MASTER

DRY-LANDS RESEARCH INSTITUTE

UNIVERSITY OF CALIFORNIA, RIVERSIDE •

RIVERSIDE, CALIFORNIA 92521

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

MASTER

Population Analysis Relative to
Geothermal Energy Development,
Imperial County, California

by

James B. Pick, Tae Hwan Jung,
and Edgar Butler

DISCLAIMER

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DLRI Report No. 16

This material was prepared with the support of National Science Foundation Grant #AER 75-08793. Any opinions, findings, conclusions or recommendations expressed are those of the author (s) and do not necessarily reflect the views of The National Science Foundation.

NSF/ERDA Grant AER 75-08793
Imperial County Contract CI 75/76-1
January 1977

cp
DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

Acknowledgments

The authors would like to thank the other researchers on the full project for valuable collaboration, help, and advice. They also thank many persons in the County of Imperial (both official and non-official) for extremely generous assistance.

Table of Contents

	Page
Acknowledgments	ii
List of Tables	v
List of Figures	viii
 Section	
1. Introduction	1
2. Review of Socioeconomic Research Pertinent to Geothermal Development in Imperial County	3
2A. General Demography	3
2B. Economic Effects on Migration	7
2C. Energy Capacity and Consumption	10
3. Population and Economic Statistics for Imperial County, 1950-70	11
3A. Population Composition and Change	11
3B. Population Economics	15
3C. Housing and Transportation	22
4. Regional Socioeconomic Comparisons	30
4A. Migration and Income Characteristics	31
5. Discriminant Analyses of Geothermal Areas	34
5A. Research Design	35
5B. Applications to Geothermal Energy Development	40
6. Spanish American Population of Imperial County	42
6A. Resident MA's	43
6B. Illegal Mexican Aliens	50
6C. Interactions with Geothermal Energy Development	53
7. Regional Employment Implications for Geothermal Energy Development	54

Section	Page
7A. Farm Labor Force Reduction Based on Land Area Analysis	54
7B. Regional Regression Analysis for Employment	55
8. Population Projections	76
9. Transferability of Methods and Results	83
References	86
Figures	93

List of Tables

Table		Page
1.	Population and Sex Ratios for California and Imperial County for 1910 to 1970	4
2.	Spanish-Speaking Population in Imperial County 1950-1970	6
3.	Measures of Fertility and Mortality for Imperial County From 1950 to 1974	13
4.	Immigration for Segments of Imperial County Population, 1965-1970	16
5.	Family Composition for Imperial County, Kern County, and California, 1960 and 1970	17
6.	Income Distribution for Imperial County 1950-1970 with Classification Subject to Inflation	18
7.	Male Employment Categories for Imperial County 1950-1970	19
8.	Industrial Distributions for Imperial County, Kern County, and California, 1950-1970	20
9.	Nonagricultural Industrial Distributions for Imperial County, Kern County, and California, 1950-1970	21
10.	Poverty and Unemployment for Imperial County, Kern County, and California, 1970	23
11.	Size and Crowding in Housing for Imperial County and California, 1950-1970	24
12.	Housing Values for Imperial County and California, 1950-1970, with Classes Scaled for Inflation by Consumer Price Index	25
13.	Air Conditioning and Heating Equipment for Imperial County, 1970	26
14.	House Heating Fuel Mix for Imperial County, 1970	28
15.	Transportation--Means to Work Imperial County, Kern County, and California, 1960	29

Table		Page
16.	Immigration Rates for Selected Towns in Imperial County, 1970	32
17.	Geographical Distribution of MA Population	36
18.	List of Variables in Discriminant Analysis	37
19.	Discriminant Analysis of Geothermal Regions by Socioeconomic Characteristics	39
20.	Completed Fertility by Ethnic Group	45
21.	Age Structure by Ethnic Group and Sex for Imperial County, 1970	46
22.	Income for Families and Unrelated Individuals by Ethnic Group	47
23.	Education by Sex and Category for Imperial County, 1970, for Persons of Age 25+	48
24.	Occupational Distribution of Imperial County Population by Ethnic Group and Sex for Persons Age 16+	49
25.	Major MA Occupational Group in Major Towns	51
26.	Farm Labor Force Displacement by KGRA, Plant Capacity, Farm Worker Income, and Land Reduction for Average 100 Acres	56
27.	Farm Labor Force Displacement by KGRA, Plant Capacity, Farm Worker Income, and Land Reduction for Field Crops	57
28.	Poverty and Unemployment by Ethnic Group for Imperial County, 1970	58
29.	Agricultural Labor Force Reduction From Geothermal Development--JPL Scenario	59
30.	Means and Coefficients of Variation for Independent Variables	64
31.	Means and Coefficients of Variation for Dependent Variables	66
32.	Beta Coefficients, Multiple Correlation Coefficients and Percent of Variance Explained by Selected Enumeration District Characteristics for Dependent Variables, Geothermal Sample	69

Table		Page
33.	Beta Coefficients, Multiple Correlation Coefficients and Percent of Variance Explained by Selected Enumeration District Characteristics for Dependent Variables, Entire Sample	70
34.	Beta Coefficients, Multiple Correlation Coefficients and Percent of Variance Explained by Selected Enumeration District Characteristics for Dependent Variables, Non-Geothermal Sample	71
35.	Summary of Population Projections for Imperial County	77
36.	Age Distributions of Populations Projected to Year 2020	81

List of Figures

Figure		Page
1.	Comparative Age Structures for Imperial County, 1950-70	94
2.	Age Structure for Imperial County, 1950	95
3.	Age Structure and Age-Specific Migration for Imperial County, 1960	96
4.	Age Structure and Age-Specific Migration for Imperial County, 1970	97
5.	Percent Spanish-Speaking, County of Imperial (ED and KGRA Boundaries Superimposed)	98
6a.	Dependency Ratio, County of Imperial	99
6b.	Dependency Ratio, City of Brawley	100
6c.	Dependency Ratio, City of El Centro	101
6d.	Dependency Ratio, City of Calexico	102
7a.	Percent of Total Male Labor Force, Entire County	103
7b.	Percent of Labor Force Males, City of Brawley	104
7c.	Percent of Labor Force Males, City of El Centro	105
7d.	Percent of Labor Force Males, City of Calexico	106
8.	Percent of Total Female Labor Force, County of Imperial	107
9.	Mobility (Different House/Total Houses), Count of Persons 5 Years Old and Over by Residence in 1965	108
10.	County Mobility (County Migration/Total Houses), Count of Persons 5 Years Old and Over by Residence in 1965	109
11.	State Mobility (State Migration/Total Houses), Count of Persons 5 Years Old and Over by Residence in 1965	110

1. Introduction

Geothermal energy worldwide exists in diverse geological, ecological, climatic, and socioeconomic settings. A multitude of factors from these settings affects the steps of exploration, drilling, electrical production, nonelectrical uses, associated industrialization, and eventual cessation of production field due to depletion. The oldest developed field in Lardarello has been producing electrical energy since 1904 (Wehlage, 1975). Lardarello has geologic features of steam fields, large production area, and others. Current production is 404,600 kW (Wehlage, 1975). The socioeconomic setting has included much rural property in surrounding regions, relatively small amounts of nonelectrical use, long distance from large Italian population centers, and since 1967 a national policy of control of resource development by the Italian Federal Energy Agency.

In Sonoma County, California, the single U.S. field of substantial electrical development (502,000 kW in 1974), a rich steam resource underlies a hard rock geologic strata. In its early history this resource manifested itself in vacation spas with hot baths, and many hot springs. From a socioeconomic standpoint the Sonoma-Lake County resource is located underneath a sparsely populated, hilly area containing retirement and vacation areas and a few small and rather unproductive farms. Vollintine and Weres (1976) estimated a population of 50 persons in field location of extreme northwest Sonoma County, and 5,000 persons who might be exposed to geothermal development in Lake County.

Although there are few people in surrounding areas and nearly all of the energy is placed on power grids to northern California population centers, the local population and economic characteristics are important to energy development. From an energy development standpoint, they act as geothermal labor supply (more highly skilled labor is mostly brought in from outside), sellers and renters of geothermal land, and as a supplier of indirect (and some direct) services to support geothermal operations. From a broader perspective they are important as voters and contributors to public opinion on geothermal issues--part of which affects public policy. The importance of such public opinion is evident in the environmental restrictions on geothermal development, especially in Lake County (Vollintine and Weres, 1976).

Besides Lardarello and Sonoma County, there are other examples of adaptations of human communities to an always unique resource. This report intends to examine the historical and current population characteristics of Imperial County, California. These include such features as vital rates, urbanization, town sizes, labor force composition, income, utility usage, and ethnic composition. From this basic data inferences are drawn on some of the important social and economic processes. Multivariate statistical analysis is used to study present relationships between variables. Another intent of

the report is to speculate on the adaptation or range of adaptations that the county's population will follow, as geothermal plant capacity is scaled up. Such speculation may only be confirmed by standardized comparisons after an energy capacity has been added.

To accomplish the above goals this report is divided into nine sections. Section 2 reviews historical studies and past research which relates in methods or results to the present work. Section 3 analyzes population trends for the county as a whole. Since U.S. Census data on counties was collected in much greater detail beginning with the 1950 Census, nearly all data series and trends are for the period 1950-70.

Subcounty data is analyzed in Section 4 for 1970. The geographical unit used here is the enumeration district, a U.S. Census population grouping with an average size in Imperial County of 931 persons. Regional trends in characteristics such as ethnic composition, dependency ratio, and mobility are studied, and compared with each other for energy development implications. This latter analysis is carried further in Section 5, which investigates characteristics which distinguish enumeration districts overlying geothermal fields from those not overlying fields.

Since in Sections 1-5 the ethnic variable is shown to be of key importance, Section 6 looks at the population of the county's largest ethnic group, Spanish American. In Section 7, two analyses are conducted of county employment--the first specific for farm labor displacements in relation to plant capacities and the second a regression study of three broad factors affecting regional employment: age eligibility, participation and unemployment. Section 8 performs population projections for the county under historical, standard, and "geothermal" projection assumptions.

The final part of the report, in Section 9, examines the transferability of methods and results to other geothermal regions anticipating energy development. It is shown that many techniques used are transferable to any geothermal area in the United States, with certain alterations in approach to suit local conditions. It is hoped that, through Section 9, the report may be of methodological use to energy planners and policy makers, either local, state, or federal, in areas already developed such as Lardarello or Geysers, or in regions contemplating utilization of a geothermal resource.

2. Review of Socioeconomic Research Pertinent to Geothermal Development in Imperial County

2A. General Demography

The general demography of Imperial County lags an urbanization-industrialization trend which has characterized California's population history (Thompson, 1955). In the U.S. Census of 1970, Imperial County remained 32.1 percent rural, compared to a value of 9.1 percent rural for the state. The state, by comparison, reached the 32.1 percent value in 1920. Small business size (less than 60 employees) characterizes the valley's business structure (Imperial County, 1973). Such a rural, small business, small town character is a proportionally rare feature in California in 1976.

In population size trends as well, the valley differs from statewide history. Total populations of state and county for 1910-70 are given in Table 1. The wide-growth differential is not accounted for by differences in fertility or mortality, but by differences in interstate and intrastate migration patterns. Throughout urban California, industrial growth has continued economically to attract migrants from the East. However, a well-known feature of the agricultural component of the U.S. has been a trend towards increasing mechanization and decreasing manpower requirements. Hence growth of agriculture in the county of Imperial has not spurred population increase over the past 45 years.

In fact, due to natural increase, the above figures indicate a net migration loss to the county in every intercensal period since 1930. It has been proven in the population literature that economic, job-seeking motivation is the primary determinant of migration in the U.S. (Sablen, 1964; Lansing and Mueller, 1967; Morrison, 1972). Thus one can speculate on greater job attractiveness pulling some persons (mainly young adults) away from the county.

The most recent state projection figure for county population in 1975 is 84,100 (State of California, 1976). If the projection is accurate, it would indicate at least a net migration which is balanced to zero--a change in the prior trend. This would correlate well with U.S. Census findings of the past several years, showing a nationwide trend towards return to rural areas. Geothermal development will either be negligible in effect or increase immigration. Projection of future county population (see Section 8) will contain migration as the critical component.

Several other general features of the county should be noted. In 1970 the county was 45 percent Spanish American, according to the Census designations

TABLE 1. POPULATION AND SEX RATIOS FOR CALIFORNIA AND IMPERIAL COUNTY FOR 1910 TO 1970

	<u>Imperial</u>	<u>SR1</u>	<u>California</u>	<u>SR2</u>	<u>SR1/SR2</u>	<u>Mexico</u>
1910	13,591	1.90	2,377,549	1.25	1.52	15 160 369
1920	43,453	1.48	3,426,861	1.12	1.32	14 334 780
1930	60,903	1.36	5,677,251	1.08	1.26	16 552 722
1940	59,740	1.23	6,907,387	1.04	1.18	19 653 552
1950	62,975	1.19	10,586,223	1.00	1.19	25 791 017
1960	72,105	1.24	15,720,860	.99	1.25	34 923 129
1970	74,492	.98	19,953,134	.97	1.28	48 313 438
1970	83,492*	1.24				

*Includes border commuters

SR1 = Imperial County sex ratio

SR2 = California sex ratio

Source: U.S. Bureau of the Census, 1910-70

of either Spanish language or Spanish surname (see Table 2). This compares to 14 percent for the state. Demography of Spanish Americans has been researched extensively (Grebler, 1972; Bradshaw, 1973; Uhlenberg, 1973). A key conclusion of these studies is higher fertility for Mexican Americans (henceforth, Mexican American is abbreviated as MA) compared to the white population. Citing 1960 Census data, Uhlenberg notes that MA fertility, measured by total childbearing per woman, is 80 percent higher than that of native whites. For 1970 Census data of five southwestern states including California, Bradshaw (1973) gives a total childbearing rate which is elevated 61.1 percent for persons of Mexican origin over whites of other origin, and 45.1 percent higher for Spanish language or surname persons over whites of other origin. In Imperial County this influence is revealed by the county's leadership in fertility among all California counties (State of California, Department of Public Health, 1970). Even assuming a 50 percent average extra fertility per ten-year intercensal period, the ethnic factor would account for about a 5 percent addition of population over ten years, a small increment compared to immigration which characterized the state from 1930 to 1970.

Other population characteristics of the county are low average income, urban concentration in towns of 4,000 to 20,000, low average educational attainment, low average age, and occupational concentration in agriculture and related areas (Imperial County, 1973; U.S. Census, 1973). A special occupational feature of the county is the proximity of the international border. A labor pool, with residence in Mexicali, travels to work in the county every day, and returns in the evening. This pool has important seasonal fluctuations (U.S. Senate, 1970; Kjos, 1974; Nathan Associates, 1968), with peak daily border crossings in January and late May, in correspondence to crop harvesting demand. In the early 1960's, daily commuters varied seasonally from 4,700-8,000 per day (U.S. Senate, 1971). These figures are perhaps 50 percent higher in 1976. There are also legal and illegal aliens who reside in the county, many of whom add to the labor force (U.S. Senate, 1971).

Due to the large labor pool originating in Mexicali, it is important to look at the population growth south of the border, 1950-70. The following chart shows the growth of Mexico and Northern Baja California for these years. (Population is in thousands.)

	<u>Northern Baja</u>	<u>Mexico</u>	<u>Mexican Birth Rate</u>	<u>Death Rate</u>
1950	227	25,791	45.5	16.2
1960	520	34,923	44.6	11.2
1970	1,105 (est.)	48,313	46.0 (1975)	8.0 (1975)

(Modified from Whetten, 1971)

In contrast to the prior table for Imperial County, the size of the Baja region has more than doubled for the last two 10-year periods, whereas Mexico has increased by approximately 40 percent each period. North of the border, population is lagging statewide and national trends; south of the

TABLE 2. SPANISH-SPEAKING POPULATION IN IMPERIAL COUNTY 1950-1970

<u>Spanish-Speaking Definition</u>	<u>Imperial</u>	<u>Kern</u>	<u>California</u>
1950:			
Mexican Birth	.135	.015	.015
Mexican Origin (Est.)	.371	.041	.041
1960:			
Mexican Origin	.272	.050	.044
1970:			
Mexican Birth			.020
Mexican Origin	.304	.071	.055
Spanish Language	.449	.155	.137
Spanish Origin or Descent	.403	.151	.118
Spanish Mother Tongue	.413	.130	.107

NOTE: Mexican origin for 1950 estimated from 1970 data

SOURCE: U.S. Bureau of the Census, 1950-70

border, the Mexicali region and Northern Baja are greatly exceeding national trends. One can easily surmise here a potential pressure for increased legal and illegal border crossings. Mexicali itself has increased greatly to become by 1974 the fifth largest Mexican city, rapidly approaching the half-million size (Kjos, 1974). However, since the number of "green card" holders is, in the final analysis, a diplomatic decision of the U.S. Federal Government, border crossings have remained steady. Illegal immigration is postulated to have increased greatly in the last ten years (Dagodog, 1975).

The above picture of Imperial as an agricultural, slow-growth region may be altered by the advent of geothermal resource development. For population projections, it is important to speculate on possible change in the demographic determinants. Mortality levels are not postulated to be lowered significantly in the near future. Although fertility is likely to continue to be amplified by the large number of MA's and to be cyclical in accordance with past U.S. patterns, geothermal energy developments would appear to have possible fertility influence only through the mechanism of reducing the MA percentage of the population through an immigration increment of skilled workers, with a smaller percentage MA.

2B. Economic Effects on Migration

More significant future geothermal population change may take place if immigrants are attracted by geothermal economic effects. The key factor would appear to be potential industrialization of the county related to the new energy source. Before examining causes of industrialization more specifically related to Imperial Valley and geothermal energy, it is important to look at general studies of industrialization in rural areas.

Ginther, et al. (1974) studied factors in location of 330 out of 1,900 present industrial plants in Nebraska. The following question was asked of the businesses: "At the time the decision was made, how important were the following factors in selecting your present location?" Responses were graded on a scale 0-3, and revealed the following seven most important factors out of 43 (with score in parentheses):

1. Labor quality	(645)
2. Highway transportation	(640)
3. Labor availability	(637)
4. Available site	(604)
5. Reliability of electric service	(585)
6. Wage rates	(582)
7. Proximity to market	(562)

Electric rates (514) were 12., and eight community attractiveness factors (474 or less) ranged between 17. and 35. Although energy was of some importance, the major decision influences were labor force and transportation. Since neither in quality nor quantity of labor force does Imperial County compare to such metropolitan regions as Los Angeles and San Diego, one must regard this study as a somewhat pessimistic reflection on geothermal industrial potential, at least the electrical component.

A second study of rural industrialization (Fulton, 1974) was written from the experienced viewpoint of an executive in the consulting business of locating plants. A general trend is noted of locating new plant locations in rural areas. For instance, one-third of new manufacturing job openings in 1962-69 were in the small, nonmetropolitan areas. Causes alluded to were journey to work frustrations, fear of physical attack, air and noise pollution, high living costs, and economic anxiety. A second statistic mentioned was 50 percent higher living costs in New York City than in communities of less than 50,000. With the large suburban growth of 1960-70 (Hauser, 1971), it is logical to ask why industry did not choose mainly suburban locations. Fulton notes suburban problems of pollution, blight, bad land use, transportation difficulties, intergovernmental conflict, rising land costs, and labor shortages. The answer of rural location is favored by closeness of workers to the job, more space for dispersion of plant pollutants and waste heat, cheaper and more available land, greater governmental interest, etc. Fulton lists characteristics of the best communities for rural industrialization as follows: good highway system (preferably a national interstate), strong leadership in the community, informed about government programs, nondomination by a single large industry influencing the labor market, labor availability, and easy access to the facilities and services of a large city (less than 50 miles distance). The conclusions for Imperial County to be drawn from the above studies are twofold: first, that the recent national trend may be somewhat favorable to a not-too-isolated semirural area, and second, that geothermal electricity may be rather secondary as a mechanism for decision-making on industrial plant locations. It will be speculated later that geothermal industrialization of nonelectrical type may offer greater reason for choice of location in the county.

Kjos (1974) investigated the potential for industrialization specifically in Calexico, the sister city of Mexicali. His study is historically illuminating, as well as pinpointing some of Imperial's issues on entry of new business.

Kjos traces the history of labor interaction between the sister cities. The Bracero Program of 1951-64 involved contracting of Mexican labor to work in the county. When this program ended, the Mexican government gave increasing emphasis to building Mexicali's economic attractiveness. An outgrowth of this was the Border Industrialization Program, initiated in 1971, which attempted to encourage mutually beneficial industrial development on both sides of the border. Kjos regards this program on the Mexicali-Calexico area as essentially unsuccessful. Thus his study asks the question, "What does Calexico wish to do to encourage its own industrial buildup?" He interviewed Calexico citizens, Mexicali business and government leaders, American businessmen who considered locating in Calexico, and American businessmen participating in the Border Industrialization Program. His conclusions are essentially negative about impetus for industrial development of Calexico, due to lack of incentives for new businesses, lack of governmental planning focus in Calexico, local tensions in regard to the border worker issue, lack of an industrial park, and other reasons. In general, he is documenting an indecisiveness in the community in regard to industrialization. It is difficult to apply results of his study outside of

the very unique border situation, but possibly the question of community decisiveness will be of importance to geothermal industrial development.

A more specific focus on industrialization in relation to geothermal resources is best achieved by separating electrical and nonelectrical users of the resource. The question of motivation for development of electrical usage has been addressed in various cost analyses for geothermal energy (Barnea, 1972; Robson, 1974; Cataldi, 1973; Armstead, 1973; Holt, 1974; Larson, 1976). Armstead (1973) presents the following range of representative capital costs for geothermal power (in thousands of dollars):

	20 MW (4 Wells)	50 MW (9 Wells)	100 MW (18 Wells)	200 MW (35 Wells)
Drilling	360	810	1,620	3,150
Exploration	3,000	3,000	3,000	3,000
Pipework	1,196	2,691	5,382	10,465
Plant	3,160	7,185	14,370	27,942
Interest	<u>632</u>	<u>1,437</u>	<u>2,874</u>	<u>5,588</u>
	5,348	15,123	27,246	50,145
\$/kW	465.4	324	270	232.6

Production costs were estimated at a .85 load factor as follows:

	20 MW	50 MW	100 MW	200 MW
U.S. mils/kWh	6.55	4.66	3.93	3.41

A scale effect is apparent here for both capital and production costs. The production costs are considerably lower than 1970 values cited by Robson (1974) of 10 U.S. mils/kWh for an oil-fired generating plant in California (for fuel costs at \$3.50/b and 12 U.S. mils/kWh for a nuclear plant. However, even with favorable costs for geothermal energy, there is the question of how much of prospective geothermal energy will be exported on the electrical grid to other parts of California. The inclination to export of energy is shown, for example, by the geothermal energy program of the City of Burbank on the East Mesa location (Baker, 1974). Also, the present hydro and fossil plants in the county and possible nuclear plant at the Palo Verde site may introduce complicated questions of the fuel mix for export and retention in the county.

It is important, also, to note that agriculture and food processing are estimated to consume about 2.5 percent of the total energy consumption in the U.S. (Steinhart and Steinhart, 1974). Thus the very large agricultural component of the county economy (Force, 1970) may expand further with larger energy sources. Increasing inputs of energy into one crop, corn, is documented to have tripled from 1945 to 1970 (Pimental, et al., 1975).

Perhaps the most difficult technological part to project in a geothermal scenario is nonelectrical use of potential production. Possible uses include heating, air conditioning, production of chemicals from brines, heat for industrial processes, such as food processing, desalting of salt water, drying or distillation of every type, heating of soil, raising of fish, etc. (Lindal, 1973; Wehlage, 1974; Barnea, 1972; James, 1970; Werner, 1970). An important consideration of such applications is that, unlike electrical use, they must be located within several km, at the most, of the production sites. Thus, in all cases, this usage would draw industry into the county, rather than to a noncounty location.

2C. Energy Capacity and Consumption

The steady level of total population of the county is presently supported by an ample local energy capability, which has evolved since the mid-1930's. Since the first energy installation in 1936 of a 2.2 mW diesel generator, installed capacity increased nearly linearly (at a smoothed linear rate of 3.4 mW/year) to 47.9 mW in 1950. From 1950-75, power plant installation again increased about linearly (at a smoothed linear rate of 12.0 mW/year) to 347.3 mW capacity in 1975. From 1940 to 1970, U.S. electrical energy production increased by a factor of 8.8 and per capita electrical production increased by 5.3 times (Fowler, 1975). By comparison, these factors for Imperial County energy capacity are respectively 12.9 and 10.4. Thus, while the county's population growth has lagged, its growth in energy capacity has greatly exceeded national rates. In fuel mix, the county has changed from steam-diesel-hydro proportions of 0:100:0 in 1940 to 52:7:41 in 1960 and to 68:11:21 in 1975. This latter compares to an estimated 1975 national mix of 76 percent petroleum and gas, 4 percent hydro, and 20 percent in other forms of energy (Penner, et al., 1974). Thus the most unusual present feature of the county fuel mix is an enlarged component of hydroelectric power.

Per capita energy consumption was estimated by discounting national consumption in 1973 and county consumption in 1975 to 1970 by the national energy consumption growth rate of 5.6 percent per year (Fowler, 1975). Per capita estimates are 8,272 kW hours for the nation and 7,325 kW hours for the county (6,530 kW hours if border commuters are included).

Lower comparative per capita consumption contrasts with higher installed capacity per capita. Whereas the 1970 total and peak demand capacities are 1.67 kW/capita and 1.35 kW/capita for the U.S. (Fowler, 1975), they are 3.59 kW/capita and 1.89 kW/capita for the county (3.20 and 1.69 with border commuters). A final crude energy consideration is the current use of county electrical generation. The 1975 ratios of residential to commercial to industrial are 42:39:14 compared to 1973 national figures of 34:24:41. The housing fuel mix of the county reveals a major difference from the statewide pattern--reduced use of utility gas (37 percent below the state level) and increased use of electricity (271 percent above the state). A possible explanation is the low price of electricity due to the relatively large component of hydroelectricity in the county.

3. Population and Economic Statistics for Imperial County, 1950-70

3A. Population Composition and Change

In number the population of Imperial County increased 22 percent from 1930 to 1970, a period in which the number of persons in California increased by 251 percent (Table 1). Assuming an average rate of natural increase (births over deaths) in this period of 1.65 percent, population would naturally have increased by 66 percent with no net migration. Thus, for 1930-70, there has been approximately a .7 percent net departure from the county per year. The most recent state projections show a July 1, 1975 population of 84,100. This projection assumes a yearly immigration rate of 1.1 percent between 1970 and 1975, an assumed reversal of the 40-year trend. This reversal, if it has taken place, would correspond to a national trend of return to rural places, which has been noted over the past several years by the U.S. Census. It should be mentioned that the state assumes about a .34 percent immigration rate for California over the 1970-75 period. These projections do not employ a count of persons in the county, the most accurate method of estimating migration and one which will not be available until the time of the 1980 census results.

Although migration is the dominant influence for California counties, in Imperial it is reduced to the order of magnitude of the vital rates--fertility and mortality. For the period 1970-74, the county's average rate of natural increase (births minus deaths) was 1.23 percent compared to a state rate of .75 percent. The corresponding values for 1960 were 1.92 percent and 1.51 percent, and for 1950 were 2.28 percent and 1.38 percent. A standard demographic feature of MA population is higher fertility (Bradshaw, et al., 1973). However, while the county's annual rate of net increase is about 65 percent higher than the state's, this differential is only partly due to MA standardized fertility. For completed cohort fertility in 1970 for ever-married women, ages 35-39, Imperial has a 49 percent additional increment for MA over non-MA fertility. When this is applied to the entire population the fertility increment due to MA's is only 23 percent. The 42 percent differential is readily explained by the young age distribution of the county, especially of the MA population, since it is well known that such youthful age distributions tend to inflate standardized fertility and deflate standardized mortality.

Without this added fertility-age structure effect, Imperial would have declined in population by about 5 percent from 1930 to 1970. Several investigators have noted a convergence between Spanish American and white

fertility over the last 15 years, but such convergence does not appear to have happened in Imperial. Perhaps this is because of the proximity to the border, the arrival of new Mexican migrants, and also possibly reduced acculturation and assimilation of the Spanish population compared to the state.

To assess this fertility influence in the future, it is necessary to look at the Census measurement of Spanish population for the last three censuses (Table 2). Five different classifications of Spanish are shown. This confusion of definitions was carefully clarified by Hernandez, et al. (1973). A longitudinal perspective may be gained only through use of the definition Mexican country of origin, which means that either a person was born in Mexico or one of his parents was. The 1950 definition of Mexican birth had to be converted to the above definition by an estimation procedure.

It is seen that although the percent of Mexican origin increased in California and Kern Counties by 35 percent and 73 percent respectively, 1950-70, it declined by 18 percent in Imperial. This figure for Imperial is not strictly comparable, since many persons of Mexican origin, who might have been classified in the county in 1960, were living in Mexicali and commuting in 1970. A rather stable level of MA population would appear correct for 1950-70. This inference is further supported by low immigration rates from other counties for Spanish American population compared to whites (see later section on migration). The potential effect of geothermal energy on the MA population may be a reduction in its proportionate size if geothermal energy brings large numbers of new persons into the county. Even if geothermal-related industrial demands are ideally suitable for this population, Federal immigration restraints will likely prevent the MA population from increasing, unless there is future change in border legalities.

Although of less importance for future demographic change in the county, mortality should nevertheless be discussed, since it tends to reflect a general level of health and medical care. Imperial had life expectancy in 1970 of 66.3 years for males and 75.2 years for females, values which closely approximate state life expectancies (see Table 3). The crude death rates appear lower than the national and California averages because of the young age distribution in the county, which will be covered below. A reverse effect takes place with age standardized fertility indices, where the surplus of young persons increases the comparative differences with crude rates.

Age structures for the county from 1950 to 1970 are shown in FIGURES 1-4. FIGURE 1 shows percentage change in the observed population. Several aspects of this graph are likely due to data collection changes and errors. The noticeable drop in percent of males aged 20 to 40 in 1970 was partly caused by the change in status of bracero population residing in the county in 1960 to green-card commuter status with Mexican residence in 1970. A second data collection anomaly is likely the increased number of males 75+ in 1960. The graph shows large percentage alterations for female age groups 0-30 and 55+, and for male age groups 0-40 and 65+. The female side of this figure can be presumed to be less subject to MA work force factors for ages 20-65. Two trends are apparent: the presence of a depression-age gap in number caused by the maturing of cohorts of persons born in the low fertility years of the

TABLE 3. MEASURES OF FERTILITY AND MORTALITY FOR IMPERIAL COUNTY FROM 1950 TO 1974

Year	Imperial Births	Birth Rate		Total Fertility Rate		Imperial Deaths	Death Rate		Life Expectancy		Life Expectancy	
		Imperial	California	Imperial	California		Imperial	California	Male	Female	Male	Female
1950	1878	29.8	23.1	3836	3007	446	7.0	9.3	62.8	69.0		
1951	1990					445						
1952	2010					512						
1953	2301					475						
1954	2206					515						
1955	2184		24.1			463		8.8			67.3	73.7
1956	2146					489						
1957	2100					520						
1958	2003					486						
1959	1922					524						
1960	1885	26.1	23.7	4347	3622	498	6.9	8.6	74.2	73.4		
1961	2057					487						
1962	1959					526						
1963	1965					561						
1964	1882					591						
1965	1722		19.2			587		8.3			67.8	75.1
1966	1755					557						
1967	1683					530						
1968	1613					590						
1969	1589					574					66.8	74.3
1970	1662	22.3	18.2	3211	2352	582	7.8	8.3	66.3	75.2		
1971	1570	20.9	16.3			565	7.5	8.3				
1972	1444	19.0	14.9			565	7.5	8.3				
1973	1490	19.1	14.4			581	7.4	8.3				
1974	1536	18.7	14.9			615	7.4	8.1				

NOTE: Life Expectancy is from age 0

SOURCE: State of California, Various Publications, 1930-75

1930's; and an increased percentage of females 30-40 in 1950, an effect possibly due to the large outmigration of younger persons in the following decades. The elderly (65+) population of the county increased by a factor of 2.5 from 1950 to 1970, and can be expected to continue increasing in the future. Another observation from this graph is the decrease in the sex ratio in 1970 as compared to 1960 and 1950. The decreasing trend in the sex ratio is apparent in Table 1 from the high levels early in the century. However, because of the presence of the green-card commuters, nearly all of whom are male, the decrease from 1960 to 1970 would appear to be a residential effect, with a maintenance of about a 1.2 sex ratio, if the population of the county were constituted of job holders and relatives of job holders. Since the sex ratio for the non-Spanish American population is 1.00 for 1970, unbalanced county sex ratios for 1950, 1960, and 1970 (adjusted) would appear to be due to the excess of Mexican agricultural labor. The implications for geothermal development of a 20 percent male excess are unclear, except that a larger labor pool is available than indicated by raw figures. If there is significant industrial development in the county, the traditional sex ratio will likely decrease, a residual of the agricultural character of a past labor force.

The large (22 percent) component of persons aged 10-20 in 1970 undoubtedly caused many dependency problems, such as strains on educational institutions and families. However, this large "baby boom" age group (ages 16-26 in 1976) may be presumed to have partially outmigrated. The stationary (life table) population distribution in FIGURES 2-4 reveals better health conditions during the 1950's and 1960's. The stable 1970 pyramid indicates a percentage-wise tendency towards an increase of aged females, but a decrease in aged males.

Migration is revealed in FIGURES 3 and 4 by subtracting the observed from the past-projected population. To study age-specific migration between 1950-70 it is convenient to aggregate ages by three larger categories: 0-29, 30-64, and 65+. Age structures for 1960 and 1970 are distorted by border commuters previously referred to. Since these workers were nearly all males, comparisons of female age structures are more accurate. In 1960 female migration rates (based on past-projected population with direction indicated) were -14.3, -11.5 and +10.0 for aggregated ages. In 1970 these rates were -10.3, +.4, and +9.2. Thus female children and young women have been leaving the county, while retirement age women have been returning. The middle age segment has changed from a strong outmigrating tendency in 1960 to neutrality in 1970. Because of the youthful age pyramid, numerically most migrants (counting in- and outmigrants equally) are in the 0-29 age category (65.2 percent in 1960 and 89.9 percent in 1970). The greatest female outmigration was for those ages of 20-24, with rates of -.257 and -.261 in 1960 and 1970. For the young, the draw of employment, educational, and life style forces in more urban, sophisticated regions of the West appear to account for such significant departure. Because of possible data unreliability, males' rates were done for ages 0-20 and 65-79. In 1960 rates were -6.5 and +12.0 for them; in 1970 rates were -4.6 and +9.7. Hence male migratory patterns also show the departure of the young and return of the old.

The age characteristics of net migration for the county are complicated further by in- and outmigration for specific segments of the population. The

U.S. Census records only immigration, in the form of data on residence five years earlier. In Table 4 it is seen that 10,691 persons immigrated into the county in 1965-70. Since there is a net outmigration rate of approximately 1 percent per year, persons immigrating perhaps yield a gross outmigration rate of over 2 percent.

It is important to note in Table 4 that the Spanish-speaking population is much more stable geographically for movement within the U.S. (only 8.1 percent were in a different county in 1965 compared to 22.1 percent for whites). This stability for movement in the U.S. is counterbalanced by a much higher international immigration (8.8 percent versus 1.0 percent for whites).

In summary, outmigration has been a key factor in the past population dynamics of Imperial County. The implications for energy development of departure from the county of large numbers of young adults and associated children will be discussed in Sections 7 and 8.

Family composition for the county is shown in Table 5. In 1960 and 1970, the high fertility in the county is clearly manifest in the large percentages of families with young children under age 6. The somewhat lesser number of families with no children under 18 for Imperial than for the state would imply greater family dependencies in the county.

3B. Population Economics

Analysis of population composition and change has revealed a region at variance with many demographic features of California, such as a balanced sex ratio, immigration of younger persons, and population increase. The county economy, primarily based on agriculture, will be a critical element in possible geothermal development.

The income distribution of the county was studied from 1950-70 by inflating all incomes by the ratio of the mean incomes for a ten-year period. To achieve a somewhat larger economic area for these inflators, Imperial's inflators were averaged with those for Los Angeles County. Incomes were inflated by 87 percent for 1950-60 and by 53 percent for 1960-70. Table 6 shows comparable income classes after multiplication by the above weights. The percent of top family incomes (above \$28,611 in 1970) appears to be rather stable over 20 years. However, the second highest and lowest income brackets consistently decreased over the period, whereas the middle groups increased by 10 percent. This trend towards middle-class categories also appears for male employment (Table 7); there then is an increase for 1950-70 of 11 percent in clerical and professional-managerial employment. (For California, this increase was only 4 percent.)

The industrial classifications for Imperial County, Kern County, and California appear in Table 8. These can be best analyzed by separating occupational divisions by sex, and by eliminating the agricultural component entirely. In Table 9 are shown the nonagricultural industrial distributions by sex for 1950-70. For males in Imperial County, the most significant change in industrial classification is an 8 percent rise in the public

TABLE 4. IMMIGRATION FOR SEGMENTS OF IMPERIAL COUNTY POPULATION,
1965-1970

<u>Residence Five Years Earlier</u>	<u>Non-Spanish-Speaking Immigration</u>		<u>Spanish-Speaking Immigration</u>	
	<u>Rate</u>	<u>Number</u>	<u>Rate</u>	<u>Number</u>
Same House	.467	17395	.473	14189
Different House	.453	16878	.402	12069
Same County	.231	8631	.321	9625
Different County	.221	8247	.081	2444
Same State	.125	4690	.061	1844
Different State	.095	3557	.020	600
Region, if Different State:				
North-East	.0071	268	.00016	5
North-Central	.0179	669	.0024	71
South	.0284	1059	.0088	263
West	.0408	1521	.0087	261
Abroad	.010	360	.088	2629
Moved 1965 (Residence Not Reported)	.070	2611	.037	1094

SOURCE: U.S. Bureau of the Census, 1971

TABLE 5. FAMILY COMPOSITION FOR IMPERIAL COUNTY, KERN COUNTY, AND CALIFORNIA, 1960 AND 1970

<u>Family Composition</u>	<u>Imperial</u>	<u>Kern</u>	<u>California</u>
1960:			
With Own Children -6	.386	.374	.309
With Own Children -18 (Additional to (1))	.262	.329	.265
Other	.352	.297	.426
1970:			
With Own Children -6	.314	.271	.260
With Own Children -18 (Additional to (3))	.311	.312	.297
Other	.375	.417	.443

SOURCE: U.S. Bureau of the Census, 1960 and 1970

TABLE 6. INCOME DISTRIBUTION FOR IMPERIAL COUNTY 1950-1970 WITH
CLASSIFICATION SUBJECT TO INFLATION

<u>Income Class</u> <u>1950</u>	<u>Percent</u>	<u>Income Class</u> <u>1960</u>	<u>Percent</u>	<u>Income Class</u> <u>1970</u>	<u>Percent</u>
10000+	3.1	18700+	3.7	28611+	2.9
5000-9999	21.2	9350-18699	19.3	14305-28610	15.3
3500-4999	15.0	7479-9349	14.8	10013-14304	19.6
1000-3499	44.8	1870-6544	50.5	2861-10012	50.8
-999	15.7	-1869	11.4	-2860	10.6

NOTE: Inflation of classifications calculated by average
inflation of mean incomes for Imperial and Los Angeles
Counties

SOURCE: U.S. Bureau of the Census, 1950-70

TABLE 7. MALE EMPLOYMENT CATEGORIES FOR IMPERIAL COUNTY 1950-1970

	<u>1950</u>	<u>1960</u>	<u>1970</u>
Employment Category:			
Professional	4.1	4.8	8.7
Farmers and Farm Managers	9.2	6.3	4.8
Managers (Nonfarm)	9.8	9.8	13.5
Clerical	3.0	2.9	4.7
Sales	4.4	4.0	5.7
Craftsmen, Foremen	11.7	11.2	17.5
Operatives	14.3	12.3	14.4
Private Household	0.0	0.0	0.0
Other Service Workers	4.7	4.2	8.0
Farm Laborers and Foremen	30.9	36.9	15.9
Other Laborers	6.4	4.2	6.2
Not Reported	1.0	2.8	.6
Aggregated Categories:			
Farm (Including Farm Managers)	40.1	43.2	20.7
Clerical and Sales	7.4	6.9	10.4
Professionals and Managers	13.9	14.6	22.2
Craftsmen and Operatives	26.0	23.5	31.9
Other	12.6	11.8	14.8

SOURCE: U.S. Bureau of the Census, 1950-70

TABLE 8. INDUSTRIAL DISTRIBUTIONS FOR IMPERIAL COUNTY, KERN COUNTY, AND CALIFORNIA, 1950-1970

	<u>1950</u>		<u>1960</u>		<u>1970</u>	
	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>
<u>Imperial County</u>						
Number of Workers	18599	4518	21613	6414	15397	8082
Labor Sex Ratio	4.12		3.37		1.90	
Agriculture	43.4	8.6	48.4	6.3	25.1	8.8
Construction--Mining	6.6	.6	4.3	.4	7.5	1.0
Manufacturing	7.1	2.0	6.6	1.9	8.5	3.2
Utilities--Sanitary	4.8	2.0	3.6 (A)	4.1 (A)	5.5	3.5
Wholesale--Retail	17.8	33.0	14.7	28.3	22.3	28.7
Public Administration	3.9	4.9	4.5	5.5	8.0	5.5
Education (Government)	1.0	8.7	1.7	10.7	4.2	12.6
Other	15.6	40.8	14.9	47.3	16.6	36.7
<u>Kern County</u>						
Number of Workers	58065	18287	69262	29011	71991	37548
Labor Sex Ratio	3.17		2.39		1.92	
Agriculture	22.0	8.1	19.1	5.5	15.4	6.0
Construction--Mining	20.8	1.8	16.2	1.5	18.5	2.3
Manufacturing	9.5	3.0	12.2	3.9	9.8	3.3
Utilities--Sanitary	1.9	.6	1.6 (A)	1.3 (A)	2.0	1.3
Wholesale--Retail	16.4	28.8	15.8	25.3	19.4	25.9
Public Administration	8.4	8.7	9.7	7.9	10.4	6.8
Education (Government)	1.8	11.3	3.1	12.0	3.8	13.7
Other	30.5	45.0	29.2	44.7	20.7	40.7
<u>California</u>						
Labor Sex Ratio	2.40		2.03		1.64	
Agriculture	9.9	2.1	6.2	1.3	4.2	1.2
Construction--Mining	11.6	1.0	9.5	1.1	8.7	1.1
Manufacturing	21.5	15.0	27.5	17.2	25.4	15.1
Utilities--Sanitary	2.1	.7	1.5 (A)	1.0 (A)	2.2	.7
Wholesale--Retail	20.8	26.0	17.6	21.0	20.6	21.7
Public Administration	6.6	6.6	6.5	5.3	7.2	5.1
Education (Government)	1.6	5.7	2.7	7.7	5.0	9.6
Other	25.9	42.9	28.5	45.4	27.7	45.5

NOTE: (A) indicates sex distribution estimated from 1970 data

SOURCE: U.S. Bureau of the Census, 1950-70

TABLE 9. NONAGRICULTURAL INDUSTRIAL DISTRIBUTIONS FOR IMPERIAL COUNTY, KERN COUNTY, AND CALIFORNIA, 1950-1970

	1950		1960		1970	
	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>
<u>Imperial County</u>						
Construction--Mining	11.7	.7	8.4	.4	10.0	1.1
Manufacturing	12.5	2.2	12.8	2.0	11.3	3.5
Utilities--Sanitary	8.5	2.2	7.0 (A)	4.4 (A)	9.3	3.8
Wholesale--Retail	31.4	36.1	28.6	30.2	29.8	31.5
Public Administration	6.9	5.4	8.8	5.9	10.7	6.0
Education (Government)	1.8	9.5	3.3	11.4	5.6	13.8
Other	27.6	44.6	29.0	63.2	22.2	40.2
<u>Kern County</u>						
Construction--Mining	26.7	2.0	20.0	1.6	21.9	2.4
Manufacturing	12.2	3.3	15.1	4.1	11.6	3.5
Utilities--Sanitary	2.4	.65	2.0 (A)	1.4 (A)	2.4	1.4
Wholesale--Retail	21.0	31.3	19.5	26.8	23.0	27.6
Public Administration	10.8	9.5	12.0	8.4	12.3	7.2
Education (Government)	2.3	12.3	3.8	12.7	4.5	14.67
Other	39.1	49.0	36.1	47.3	24.5	43.3
<u>California</u>						
Construction--Mining	12.9	1.0	10.1	1.3	9.1	1.1
Manufacturing	23.9	15.3	29.3	17.4	26.5	15.3
Utilities--Sanitary	2.3	.7	1.6 (A)	1.0 (A)	2.3	.7
Wholesale--Retail	23.1	26.6	18.8	21.3	21.5	22.0
Public Administration	7.3	6.7	6.9	5.5	7.5	5.2
Education (Government)	1.8	5.8	2.9	7.8	4.2	9.7
Other	28.7	43.8	28.9	46.0	28.9	46.1

NOTE: (A) indicates sex distribution estimated from 1970 data

SOURCE: U.S. Bureau of the Census, 1950-70

administration and government education (versus a 2.8 percent increase in these for California and a 3.7 percent increase for Kern). Again, this increase is reflective of growth in the middle class. For males, a significant difference is a county manufacturing component only 57 percent smaller than the state, but a greatly increased utility and sanitary category (304 percent larger than the state). For females in Imperial, the most important longitudinal trend is an increase of 4 percent in government education workers. On the female side, compared to California, there is an even more sharply reduced manufacturing component (77 percent less than the state). Again the utility work force is larger. In summary, eliminating the effects of agriculture and sex ratio, two agricultural counties, Kern and Imperial, appear highly similar in industrial distribution but contrast with the state.

The above analysis controls for the influence of the labor force sex ratio. For the state, this ratio fell from 2.40 in 1950 to 2.03 in 1960 and finally to 1.64 in 1970. For Imperial County the figures were 4.12, 3.37, and 1.90 respectively. It is assumed that the labor force sex ratio will continue to decrease. Thus, in considering labor market potential for geothermal-related industrialization, an important source of labor, presently only partially tapped, is females. The large gap with the state in female manufacturing employment would appear particularly important.

Table 10 compares Imperial with Kern and the state for poverty and unemployment in 1970. Imperial is significantly higher for both characteristics, perhaps reflecting agricultural unemployment (see Section 7B).

3C. Housing and Transportation

Space and crowding factors in Imperial County housing are given in Table 11. A high vacancy rate is apparent for Imperial, but may be due to seasonal factors (see Section 9). In room availability, the county slightly lags statewide trends. Thus, it is not surprising that county residents are more crowded than for the state, although the county appears to have been catching up relatively since 1950.

For value of housing in the county, an analysis was performed which inflated home prices over the two decades by the consumer price index. Table 12 reveals a consistent lag of the county behind statewide home prices. The sharp increase in the highest priced homes in Imperial from 1950 to 1960 is unexplained. Although behind the California increase in value in the 1950's, for the 1960's Imperial's homes experienced an increase in value of 124 percent compared to 95 percent for the state.

Data on air conditioning, heating equipment, and appliances are shown in Table 13. As expected for the climate, the county has three times as much air conditioning usage than the state. The decreased heating needs are shown by comparisons of the aggregated category of room heaters, fireplaces, stoves, portable heaters, and no heaters. This combined category was 54.1 percent for county housing in 1970, versus 22.7 percent for the state. Also, Imperial has rather reduced appliance utilization. The present tradeoff between increased air conditioning and decreased home heating and

TABLE 10. POVERTY AND UNEMPLOYMENT FOR IMPERIAL COUNTY, KERN COUNTY, AND CALIFORNIA, 1970

	<u>Imperial</u>	<u>Kern</u>	<u>California</u>
Percent of Families Below Poverty Level	16.1	12.6	11.9
Unemployment:			
Percent of Males Age 14+ in Labor Force and Unemployed	7.1	4.2	4.2
Percent of Females Age 14+ in Labor Force and Unemployed	6.4	2.9	2.8

SOURCE: U.S. Bureau of the Census, 1970

TABLE 11. SIZE AND CROWDING IN HOUSING FOR IMPERIAL COUNTY AND CALIFORNIA, 1950-1970

	<u>1950</u>		<u>1960</u>		<u>1970</u>	
	<u>Imperial</u>	<u>California</u>	<u>Imperial</u>	<u>California</u>	<u>Imperial</u>	<u>California</u>
Population/Occupied Unit	3.6	3.0	3.6	3.1	3.5	3.1
Housing Units	17904		21916		23401	
Percent Owner Occupied	43.8	50.4	46.8	53.2	51.9	51.6
Percent Renter Occupied	48.4	42.3	37.4	37.9	37.8	42.3
Vacant Year Round	5.9	4.9	12.4	8.8	9.2	5.7
Number of Rooms:						
1-2	24.6	14.6	18.8	10.9	10.4	8.6
3-4	40.5	38.8	37.8	35.8	39.2	36.4
5-6	24.8	28.7	36.1	44.9	40.1	42.3
7+	5.1	7.7	7.1	8.2	9.2	12.5
Median Number Rooms						
Crowding in Occupied Units--						
Persons/Room:						
1.00 or	65.6	89.5	78.3	92.2	80.6	92.0
1.05-1.50	13.4	6.0	21.6	6.2	11.8	5.5
1.51	17.3	3.0	21.6	1.4	7.5	2.3
Median Number Persons	3.2		3.2		3.0	

SOURCE: U.S. Bureau of the Census-Census of Housing, 1970

TABLE 12. HOUSING VALUES FOR IMPERIAL COUNTY AND CALIFORNIA, 1950-1970, WITH CLASSES
 SCALED FOR INFLATION BY CONSUMER PRICE INDEX

1950			1960			1970		
<u>Housing Classes</u>	<u>Imperial</u>	<u>California</u>	<u>Housing Classes</u>	<u>Imperial</u>	<u>California</u>	<u>Housing Classes</u>	<u>Imperial</u>	<u>California</u>
0-5999	57.6	17.2	0-7499	34.3	11.8	0-9999	28.1	4.7
6000-9999	23.5	36.5	7500-12499	33.5	38.1	10000-14999	28.4	10.7
10000-19999	16.5	39.2	12500-24999	24.4	26.0	15000-34999	38.7	67.0
20000+	2.2	7.0	25000+	7.5	3.8	35000+	4.6	17.3
Median Value	5245	9564		6200	12500		13900	24400

SOURCE: U.S. Census of Housing, 1970

TABLE 13. AIR CONDITIONING AND HEATING EQUIPMENT FOR IMPERIAL COUNTY, 1970

	<u>Imperial</u>	<u>Kern</u>	<u>California</u>
% of Units Air Conditioned	77.2	34.6	24.9
Heating Equipment:			
Steam or Hot Water	.2	1.7	3.1
Warm Air Furnance	25.2	30.7	35.1
Built-In Electric Units	9.0	2.7	6.7
Floor, Wall, or Pipeless Furnace	11.0	42.9	32.1
Room Heaters	29.4	17.2	18.3
Fireplaces, Stoves, or Portable Heaters	19.8	3.7	3.6
None	4.9	.8	.8
Appliances:			
Washing Machine	65.6	71.6	65.5
Clothes Dryer	16.9	40.0	41.8
Dishwasher	12.1	22.7	26.8
Food Freezer	21.3	26.7	20.9
TV	81.3	87.8	94.7

SOURCE: U.S. Census of Housing, 1970

appliance usage will likely be considerably altered, if multipurpose use of geothermal energy were fully exploited. Geothermal has been used elsewhere for space heating as well as air conditioning.

The housing fuel mix of the county is shown in Table 14. major difference from the statewide pattern is reduced use of utility gas and increased use of electricity. A possible explanation is the low price of electricity due to the relatively large component of hydroelectricity in the county.

Transportation statistics for Imperial were compiled by the census only in 1960, and are given in Table 15. These are extremely close to the state, and reveal a predominance of automobile transportation. Auto transportation is estimated to be currently in the range of 80-85 percent.

TABLE 14. HOUSE HEATING FUEL MIX FOR IMPERIAL COUNTY, 1970

<u>House Heating Fuel</u>	<u>Imperial</u>	<u>Kern</u>	<u>California</u>
Utility Gas	54.4	86.9	85.9
Fuel Oil, Kerosene, Etc.	.7	.4	.6
Coal or Coke	0.0	0.0	0.0
Wood	.9	.3	.6
Electricity	31.9	4.8	8.6
Gas (Bottled, Tank, or LP)	7.3	6.8	3.1
Other Fuel	0.0	.1	.2
None	4.5	.4	.7

SOURCE: U.S. Census of Housing, 1970

TABLE 15. TRANSPORTATION--MEANS TO WORK IMPERIAL COUNTY, KERN COUNTY, AND CALIFORNIA, 1960

<u>Means of Transport</u>	<u>Imperial</u>	<u>Kern</u>	<u>California</u>
Private Auto or Car Pool	.699	.816	.735
Bus or Streetcar	.071	.020	.083
Walked	.080	.065	.060
Other	.063	.032	.020
Worked at Home	.062	.038	.049
Not Reported	.025	.026	.048

SOURCE: U.S. Census, 1960

4. Regional Socioeconomic Comparisons

In order to elucidate important county trends, socioeconomic characteristics relevant to energy were studied by computer mapping between energy regions. Data for county enumeration districts (henceforth called ED's) were obtained from the fifth count of the 1970 Census (U.S. Bureau of the Census, 1974). These data were displayed using Automap II, a standard computer mapping program (Environmental Systems Research Institute). Five levels of data values were chosen, with extremes approximately eighths or sixteenths. Since 58.6 percent of the county's population resides in the towns of Brawley, Calexico, and El Centro, and another 35.7 percent lives in the central irrigated valley, the central valley and the largest three towns were mapped separately.

Geothermal energy is legally located underneath surface areas called Known Geothermal Resource Areas (KGRA's). FIGURE 5--a map of percent Spanish-speaking for the central valley--has superimposed on it a map of the three presently reported central valley KGRA's. For all analyses an ED was identified as geothermal if more than 50 percent of its surface area was contained within a KGRA. In addition, because of their size and location just outside the Heber KGRA border, ED's in the towns of Calexico and El Centro were identified as geothermal. Although not mapped, an ED in the lower East Mesa contains a promising KGRA which is being actively drilled by Republic Geothermal Corporation. However, this ED contains extensive land area and few of its 259 residents are likely to be affected; hence it was not identified as geothermal.

Using computer mapping technology, regional and geothermal results are presented below for the following characteristics: Spanish language, dependency ratio, labor force availability, mobility, income, and rental market over \$100. Spanish language residents show a concentration in Calexico and periphery (31 percent of MA's in county) and in Brawley and periphery (22.9 percent). Thus in the Heber KGRA and Brawley-Salton Sea KGRA's, the Spanish-speaking are of particular importance. Within towns, a directional axis of MA composition is apparent: southeast (high) to northwest (low) for Brawley; northeast (high) to southwest (low) for El Centro; and south (high) to north (low) for Calexico. In drilling and geothermal plant locations near these towns, such well-defined axes may be a consideration.

A dependency ratio (FIGURE 6) was calculated and mapped (persons aged under 18 plus persons 65 and over/persons 18 to 64). This measure is ethnically biased because of the very large portion of children and adolescent MA population. Thus dependency closely corresponds to percent MA ($r = .44$), with a greater than average concentration in KGRA's. Directional axes for the towns are not apparent for dependency, but areas of highest

concentration are present in east-central Brawley, northeast El Centro, and north Calexico. The opposite locations of high dependency and high percent MA for Calexico is due to the large percentage of young family housing for both ethnic groups in the north.

Male labor force availability (FIGURE 7) is defined as the number of males 17-64/total number of males. By definition, it is inversely related to dependency, although the latter includes both sexes. For the northern combined KGRA, male labor force availability is very low in peripheral areas, but high in Brawley. For the southern KGRA, a medium level is apparent with El Centro medium and Calexico low. Brawley, which contains the preponderance of persons in the northern geothermal areas, clearly offers in addition an age structure favoring male work availability. Within the towns, this characteristic is highest in the two northern corners and west-central part of Brawley, the northeast corner of El Centro, and the southwest corner of Calexico.

Female labor force availability (FIGURE 8) is very highly correlated ($r = .58$) with that of males. Major differences are the reduction in female relative to male level in the highest income areas of southwest Brawley, El Centro and north Calexico. A similar reduction in the southwest part of Calexico, an area of farm labor activity, may be due to a reduced availability of married housing.

4A. Migration and Income Characteristics

Inmigration to the county was studied by ED for 1965-70. In Table 16 is shown immigration data for four towns. El Centro leads in interstate migration as one would expect for the major county town. Calexico is characterized by the highest residential intercounty and foreign immigration, but the second lowest interstate inmovement. In the central business district, ED 68, the immigration rate from abroad equals 29.7 percent. These figures for Calexico are even more remarkable when one recalls that the county, including this town, has been subject to about a 1 percent outmigration per year. The town has balanced its population at a level of about 10,000 by flows in and out.

Regional mobility patterns were studied by 1965 residence in a different house (household mobility), different county (county mobility), and different state (state mobility) (FIGURES 9-

11). These data are for inmovement rather than outmovement. Hence for a county in which outmovement has predominated, the bulk of total moves is ignored. However, since town populations were very stable between 1960-70, it may be assumed that regional outmovement levels are highly correlated with inmovement levels as measured. These data show that mobility up until now does not correspond to KGRA boundaries. Household mobility has high rates in rural and peripheral areas in the eastern third and southern third of the central valley, except for the southeast corner; relatively high mobility in the northeast third; and medium to low levels in major towns. County mobility in nonurban areas in the northwest third is low in level, with moderate levels for the remainder; the cities of Calexico and Brawley had moderate rates while El Centro was high.

TABLE 16. INMIGRATION RATES FOR SELECTED TOWNS IN IMPERIAL COUNTY,
1970

	<u>Brawley</u>	<u>El Centro</u>	<u>Calexico</u>	<u>Niland</u>
Different House	48.1	55.9	60.9	45.7
Different County	7.3	10.8	18.6	11.8
Different State	4.8	9.4	4.7	3.3
North-East	.1	.8	.5	.0
North-Central	.8	.2	.0	3.3
South	1.3	2.6	2.5	.0
West	2.6	4.1	1.6	.0
Abroad	1.3	2.5	15.3	1.5

Since interregional mobility has been found to be an important correlate of other social variables, including vital rates and prospective mobility (Butler, 1969; Pick, 1974), planners concerned with the labor force in El Centro should note the high mobility, with a decreasing gradient from west to east. Since interstate immigrants compose only 30 percent of intercounty immigrants, they are of less importance. The most notable feature, again, is elevated levels for El Centro and adjacent areas to the east and west.

Regional income differentials are very sharply defined, with higher incomes in El Centro, western rural El Centro, Holtville, and rural Calexico to the east. Rural parts of the Salton Sea and Brawley KGRA's and the town of Heber are at the lowest level of income. A general countywide gradient for rural areas runs from north (high) to south (low). Clear income axes exist in Brawley (west-high to east-low), and in Calexico (north-high to south-low). Regionally, the location of rentals in the rental market above \$100 corresponds very closely to income-- r (percent rentals \$100-149 in the rental market, percent family income \$9-25,000) = $-.48$, while r (percent rentals \$200-249, percent family income \$9-25,000) = $.4$.

In summary, the county appears to follow well-defined regional patterns for the variables studied. In geothermally active regions, such information may contribute to future industrialization patterns related to the energy.

5. Discriminant Analyses of Geothermal Areas

Previous sections have analyzed aggregated county population-economic data and regional county data. Discriminant analysis was performed in order to distinguish geothermal and nongeothermal regions of the county from each other. Discriminant analysis answers the question, "Of all variables under consideration which one (or which several together) is the best to use in distinguishing the regions?" The potential usefulness of such results to geothermal planners is that the county may be able to estimate more accurately characteristics which distinguish recipients of localized effects of energy development, such as noise, smell, and, to a certain extent, nonelectrical.

Discriminant analysis is explained as follows (more detailed explanation is available in books by Lachenbruch (1975) and Eisenbeis and Avery (1972)). Variables (say three in number) are chosen to do the discrimination (these are x_{1*} , x_{2*} , x_{3*} , where the * stands for either A (for sample unit A) or B (for sample unit B)). The sample units in the present study are ED's. For sample units A and B, the following equations may then be established:

$$y_A = c_1x_{1A} + c_2x_{2A} + c_3x_{3A} \quad (\text{Equation 1})$$

$$y_B = c_1x_{1B} + c_2x_{2B} + c_3x_{3B} \quad (\text{Equation 2})$$

The c 's are constants which are chosen to obtain y_A as different in value from y_B as possible. The x 's are referred to as independent variables.

In stepwise discriminant analysis, which is used in the Imperial County study, one begins with a long list of candidates for independent variables, say x_1 , x_2 , x_3 , x_4 , x_5 , x_6 , x_7 , and x_8 (examples of x 's from the Imperial study are percent below poverty level and percent now married). First, one x is chosen (with corresponding c) for Equations 1 and 2; then two are chosen; then three, and so on until all eight are chosen. One then picks out (to put it simply) equations having the least number of x 's which give good results on distinguishing the y 's.

After one has chosen discriminant equations, one may use these with the data at hand to see how good a job they do in classifying sample units (e.g., for ED's, classification as a geothermal or nongeothermal region). The apparent error rate gives the fraction of sample units (ED's) in a region (e.g., geothermal, nongeothermal) which were erroneously classified.

5A. Research Design

Geographical identification of ED's was accomplished by superimposing KGRA over ED boundaries (FIGURE 5). The East Mesa KGRA was omitted from this analysis because it is contained within a single ED (ED 2) which is spread over such a large land area that less than 50 percent of the land area is within the KGRA.

Three problems complicate the above identification: (1) fractional boundary overlaps, (2) lack of sufficient number of ED's in a KGRA, and (3) urban population irregularities.

Boundary overlaps were resolved as follows. If more than 50 percent of an ED is contained within a KGRA, it is classified as being geothermal and belonging to that KGRA. It can be seen in FIGURE 5 that the Salton Sea KGRA contains only one ED, according to the above criterion. There are no definite rules in discriminant analysis on the minimum number of sample units in a classification category, but a total of one, as in the Salton Sea case, is considered too small. This problem was resolved by combining KGRA's in cases where the number of sample units in a KGRA is considered too small. Thus the Salton Sea sample units are sometimes combined with the Brawley sample units, and the resultant larger unit henceforth is referred to as the Brawley-Salton Sea CKGRA (consolidated KGRA). In some analyses, all three KGRA's are combined together, and the region containing ED's for all three KGRA's is henceforth referred to as Geothermal. Non-KGRA ED's, outside urban areas, are referred to as Nongeothermal.

Urban population irregularities are due to the circumstance of location of the major towns (Brawley, El Centro, and Calexico) immediately inside or immediately outside the boundary lines. The U.S. Geophysical Survey included Brawley and El Centro within KGRA's, but excluded Calexico by a narrow margin due to a slight irregularity in the boundary (FIGURE 5). From a population standpoint, such a large proportion of county population is contained within each of these three towns (see Table 17) that it was considered uniform treatment either to exclude all three towns from KGRA's or to include all three in KGRA's. In the following analyses, both uniform classifications were used. For samples referred to as entire county, all three towns were included within KGRA's. For samples referred to as rural, the three towns were excluded from the analysis.

For the entire county sample the regions are composed of the following ED's: (1) Salton Sea CKGRA (ED's 13-28, 30, 8); (2) Heber KGRA (ED's 65-73 (including 65B), 74, 75, 43-57 (including 55B), 58, 63); and (3) Nongeothermal (ED's 29, 31, 4-7, 1-3, 59-62, 64, 32-35, 36, 37, 38-40, 41, 42, 9-12, 76-78).

For the rural sample the regions are composed as follows: (1) Geothermal (ED's 30, 8, 74, 75, 58, 63); and (2) Nongeothermal (ED's 29, 31, 4-7, 1-3, 59-62, 64, 36, 37, 41, 42, 9-12, 76-78). The rural sample thus excludes all ED's within the city limits of Brawley, El Centro, Calexico, Holtville, and Imperial.

Independent variables included as eligible for the stepwise discriminant analysis are shown in Table 18. Except for variables 19-21 and 25-27, these

TABLE 17. GEOGRAPHICAL DISTRIBUTION OF MA POPULATION

	<u>Population</u>	<u>MA Population</u>	<u>% MA</u>	<u>% of Population in County</u>	<u>% of MA Population in County</u>
<u>Urban</u>					
Holtville	3,628	992	27.3	4.8	2.8
Brawley	13,746	6,549	47.6	18.4	19.1
El Centro	19,272	6,650	34.5	25.8	19.4
Calexico	<u>10,625</u>	<u>9,701</u>	<u>91.3</u>	<u>14.2</u>	<u>28.3</u>
	47,271	22,900	48.4	63.4	69.6
Heber	710	578	81.4	.9	1.6
<u>Rural</u>					
Holtville	1,819	441	24.2	2.4	1.2
Brawley	3,069	1,317	42.9	4.1	3.8
El Centro	6,748	2,443	36.2	9.0	7.1
Calexico	<u>1,453</u>	<u>928</u>	<u>63.8</u>	<u>1.0</u>	<u>2.7</u>
	13,089	5,129	39.1	17.4	14.8
Other Population	13,422	4,661	34.7	18.0	13.6

Source: U.S. Bureau of the Census, 1971

TABLE 18. LIST OF VARIABLES IN DISCRIMINANT ANALYSIS

1. Percent Spanish speaking
2. Dependency ratio (persons (-18) + persons (65+)/persons (18-65))
3. White fertility ratio
4. Spanish fertility ratio
5. Percent labor force age males (17-64) of all males
6. Percent labor force age females (17-64) of all females
7. Percent of population now married
8. Percent of persons (5+) in a different house in 1965
9. Percent of persons (5+) in a different county in 1965
10. Percent of persons (5+) in a different state in 1965
11. Percent of persons (5+) abroad in 1965
12. Percent unemployed (white) of white population 18 and over
13. Percent unemployed (Spanish) of Spanish population 18 and over
14. Percent of labor force, white collar
15. Percent of labor force, blue collar
16. Percent of labor force, farm laborers and foremen
17. Percent of families with income less than 4,000
18. Percent of families with income 10,000-24,999
19. Percent of housing units with 3 or less persons per unit
20. Percent of housing units with 1 or - persons/room
21. Percent of housing units (Spanish) with 1 or - persons/room
22. Percent of housing units with utility gas from underground pipes as heating fuel
23. Percent of housing units with bottled tank or LP gas as heating fuel
24. Percent of housing units with electricity as heating fuel
25. Percent renter-occupied units in the \$100-250 rental market with rents \$100-149
26. Percent renter-occupied units in the \$100-250 rental market with rents \$150-199
27. Percent renter-occupied units in the \$100-250 rental market with rents \$200-249

were chosen because they were important in the analysis of crude county data. The density variables (19-21) were chosen because density has proven an important population variable in recent studies of vital rates (Pick, 1976), crime (Galle, et al., 1973), and other variables. The rental variables (25-27) were included because income was important in previously discussed crude county data--rental data provides additional refinement on household economic status.

The source of the data was the Fifth Count of the U.S. Census (U.S. Bureau of the Census, 1974)--the same data source used in the previous census mapping. After sorting and aggregation by several computer routines, the data was analyzed by a standard stepwise discriminant analysis program--Biomed. BMDP-7M (Dixon, 1976).

Results of the analysis are given in Table 19. For the entire sample with two regions (Geothermal and Nongeothermal), the distinguishing variables are utility gas, rents \$200-249 and percent Spanish-speaking. (The numbers in parentheses in this table are known in statistics as F values.) Subject to certain assumptions (Lachenbruch, 1975), these give an indication by their size of the relative importance of the independent variables in distinguishing regions.

For the entire sample, the above three variables may be important, because they are good indicators of urban-rural differences--an interpretation will follow later. For the most important of these--utility gas--the urban-rural difference is very marked (especially in the towns and adjacent areas of Brawley and El Centro and in the town of Heber). Such a difference is clearly the result of a tendency for installation of gas transmission lines in more concentrated urban areas, in contrast to greater use of electricity in rural areas. Rentals of \$200-249 (as a percent of the \$100-249 rental market) also show greater concentration in urban areas than in rural (although the high values for this variable are in two eastern rural ED's. Percent Spanish-speaking (see FIGURE 5) is very high in the Heber KGRA.

The importance of utility gas, higher rentals, and ethnicity is possibly due to a combination of geologic and human settlement reasons. The geothermal fields are contained in the Salton Trough, which extends from the Gulf of California to north of the Salton Sea, and are more likely to be on the central part of the trough. The central location of the fields is likely due to postulated, tectonic plate causation of the Imperial geothermal fields (the plate boundary is approximately central to the Salton Trough).

Likewise the irrigated valley is centrally located above the trough; and from a transportation and labor force standpoint, the county's towns were historically more likely to be centrally settled in the valley. Hence the significance of the utility gas and rental variables stems from the concentration of utility gas and higher rents in urban areas. MA preference for urban residence (Grebler, et al., 1970) leads to the importance of the MA variable.

When the entire county is analyzed for three regions (Salton Sea CKGRA, Heber KGRA, and Nongeothermal), again the urban-rural variables of utility gas and percent Spanish-speaking distinguish the regions. The above hypothesis would

TABLE 19. DISCRIMINANT ANALYSIS OF GEOTHERMAL REGIONS BY SOCIOECONOMIC CHARACTERISTICS

<u>Grouping</u>	<u>Variables Included (F to Remove in Paren.)</u>	<u>F Matrix</u>	<u>Apparent Error Rate</u>
Entire county [80] Two groups	Utility gas (27.8**) Rents \$200-249 (11.5*) Spanish-speaking (11.1*)	Nongeo. [32] Geo. [48] 21.1**	Geo. .167 Nongeo. .281
Entire county [80] Three groups	Utility gas (15.4**) Spanish-speaking (3.6*)	Heber [30] Salton [18] Heber [30] Nongeo. [32] 2.1 16.7** 16.8** (Approx. F = 11.2)	Salton .389 Heber .467 Nongeo. .344
Rural portion [31] Two groups	Spanish-speaking (12.9**)	Nongeo. [25] Geo. [6] 12.9*	Geo. .333 Nongeo. .120
Rural portion [31] Two groups Spanish-speaking variable excluded	Income \$9-24,999 (8.5*) Bottled gas (5.6**)	Nongeo. [25] Geo. [6] 5.7*	Geo. .333 Nongeo. .240

[] = number of ED's

*Significant at .95
**Significant at .975

*Significant at .99
**Significant at .9995

seem somewhat confused by the clear discrimination between Nongeochemical and Salton, and between Nongeochemical and Heber, but lack of significant distinction between Salton and Heber. The latter lack of differentiation cannot be attributed to the central versus noncentral thesis, and likely stems from lack of significant north-south socioeconomic gradients.

For the rural analysis, the key variable distinguishing Geothermal and Nongeochemical regions is percent Spanish-speaking. The explanation would appear twofold. First, nonurban ED's in KGRA's are two-thirds weighted toward the Heber KGRA, a border region with naturally higher percent Spanish-speaking. Second, the northeast adjacent ED to Brawley (ED 30) has a very high percent Spanish-speaking, so that one may discern on the map of this variable a central-noncentral gradient, less pronounced than that for utility gas in the entire county. Thus the same geological-settlement explanation which was given earlier may be applied to the rural sample.

When the Spanish-speaking variable is excluded from the analysis of the rural sample, percent of persons with income \$9,000-24,999 takes on the greatest importance. The map of this income pattern reveals an inverse effect between the Geothermal nonurban ED's (low values for this variable) and the Nongeochemical ED's (high values). The explanation of this income gradient is not clear, but is assumed to be an unusual characteristic of one particular county. The variable bottled gas would appear to be another nonurban variable--low in urban areas, high in rural--which is distributed on the central-noncentral gradient, even with exclusion of urban ED's.

5B. Applications to Geothermal Energy Development

The discriminant analysis has revealed significant socioeconomic differences between Nongeochemical and Geothermal regions, whether urban population is included or excluded. These differences are largely based on typical urban-rural variables (except for income \$9,000-24,999). Such results would appear useful to county planners, regulatory officials, certain businesses, and others for the reasons given below.

Some geothermal effects (such as noise) will be localized on KGRA land; others will be partly or fully dispersed from KGRA's (an example of the latter electrical consumption in other counties resulting from grid transmission). There are intermediate types of effects, such as nonelectrical applications which may or may not be located on KGRA land, since up to 50 km pipeline transmission of the hot water is possible, as has happened in Iceland.

It is for localized effects that the results of the discriminant analysis are of potential usefulness. For example, planners or agencies may be interested in the socioeconomic characteristics of noise recipients in comparison to nonrecipients. Assuming the noise effects will not be heard in the towns, one can conclude that, based on 1970 data, urban-rural variables (percent Spanish-speaking, bottled gas, etc.) distinguish rural KGRA recipients from rural non-KGRA recipients. For a thorough agency or county plan, such

results refine the data on recipients beyond either crude countywide data or data on individual towns. At a future date when power plant sitings become clear, planners might wish to refine the ED data further, based on exact sites.

From the prior analysis, another result of potential usefulness is that for the entire county sample, the indicator variables chosen distinguish much better between Geothermal and Nongeothermal than between the Salton CKGRA and the Heber KGRA. Thus for localized effects planners may be wiser to construct plans based on socioeconomic differences solely between Geothermal and Nongeothermal regions, and to ignore the individual KGRA's.

For nonlocalized effects (such as, for example, county per-capita electrical supply) planners, regulatory agency officials, and others are better off using the countywide data, such as presented in Section 3 of this report. Intermediate effects (for example, nonelectrical employment) cannot yet be pinpointed regionally, so they present the greatest planning difficulty. For the present, one suggestion might be to divide such intermediate effects by some percentage formula into two regions, Geothermal and Nongeothermal. Then policy could be based partly on localized and partly on countywide data results.

6. Spanish American Population of Imperial County

The 1970 population of the county was composed of 46 percent of MA's, using the U.S. Census (1971) definition of Spanish language or Spanish surname (also called Spanish "heritage"). Spanish language is estimated postenumeration by responses to the Census question, "What language other than English was spoken in this person's home when he was a child?" Spanish language means postenumeration expansion of the Spanish mother tongue designation to include all persons in households with Spanish mother tongue for the head or spouse (Hernandez, et al., 1973).

The 1970 Census Spanish surname designation is established by comparing a list of 8,000 Spanish surnames with respondent names on 20 percent of 1970 Census questionnaires in the Southwest. The designation Spanish language or surname is thus quite broad. Another designation (30.5 percent for the county) is Mexican foreign stock, defined as birth in Mexico or in the U.S., for which one or both parents were born in Mexico. The definition of Spanish language alone gives a percentage of 44.9 percent. Finally, Spanish mother tongue consisted of 41.3 percent of Imperial County's population. In the following chart, Imperial County is compared to California for these various designations.

	(1970) <u>Imperial County</u>	(1970) <u>California</u>
Mexican foreign stock	30.5	3.5
Spanish mother tongue	41.3	10.7
Spanish language	44.9	13.7
Spanish language or surname	46.0	15.5

(U.S. Bureau of the Census, 1971)

Whichever definition is used, the county has a very large and significant MA component. It is important to distinguish the legal Mexican residents of Imperial County on the basis of citizenship. Those not citizens of the U.S., and presumably citizens of Mexico, are referred to as legal Mexican aliens (abbreviated as LMA). These persons are counted in the U.S. Census as long as their place of residence is in the county.

The LMA population residing in the county is estimated from data in an unpublished report of the Immigration and Naturalization Service to be approximately 6,000 persons. Another group of LMA's are the border commuters who varied seasonally in number in 1970 between roughly 6,000 and 12,000 (estimated from U.S. Senate, 1971). Finally, the Mexican population includes the illegal Mexican alien (referred to as IMA). These are migrants who have crossed the border illegally for work or other purposes. There is no accurate estimate of IMA population in the county (see later section on IMA's).

6A. Resident MA's

In the following, MA's residing legally in the county will be considered as a group, whether citizen or noncitizen. Such a grouping is statistically logical, since the U.S. Census counts all residents whether citizen or noncitizen of the U.S.

It is important to analyze the past history of immigration and work influence, which has led up to the present situation. Although in other regions of California there was an early history of Spanish and Mexican landholding, the creation of an irrigated valley in 1901 precluded such 19th century landholding. Internationally, migration from Mexico to the United States increased around 1910 to a peak in the 1920's when about 500,000 legal immigrants came North across the border. The main causes of this increase were economic demand in the Southwest for additional labor, and the decline in arrivals of Oriental labor into the Pacific region. This influx of Mexican immigrants was sharply curtailed to only 28,000 Mexican arrivals in the 1930's because of the Depression (Grebler, et al., 1970; Samora, 1971). Due to increased demand for cheap labor in the 1940's, temporary contract arrangements were conceived which became known as the Bracero Program. However, legal immigration remained very low (54,000) in the 1940's. In the period 1947-49, legal agreements were enacted in the U.S. to formalize the contract labor arrangement, with the consequence that contract arrangements increased from 100,000 per year in 1950 to 400,000 per annum in the late 1950's. In all, from the start of the bracero idea in the mid-1940's through its demise in the mid-1960's, about 5 million contract laborers were brought into the U.S.

With the increasing employment opportunities of the 1940's, IMA entries increased greatly, as did IMA apprehensions, for which data is available. IMA apprehensions peaked at 1,000,000 in 1952, decreased to a low of 30,000 in 1960, and have increased enormously from 1965-75. An estimate of apprehensions for the Chula Vista Border Patrol Sector in 1973 (Dagodog, 1975) would extrapolate to a 1976 national level of about 950,000 apprehensions.

There has thus been a sequential series of migrations. Legal migration brought in large numbers in the 1930's; illegal entries reached a peak in 1952; the Bracero program peaked in the late 1960's; currently, illegal entries are at a maximum, having increased tremendously since 1960, while legal migration is moderate and steady. The influence of this erratic international migration history on the county would appear to have been minimal. In the 1930 Census, 35.4 percent of respondents were classified as Mexicans. The following chart compared relative percentage "Mexican" in 1930 with percentage "Spanish language" in 1970.

	<u>Imperial</u>	<u>Kern</u>	<u>California</u>
(a) 1930 percent "Mexican"	.354	.086	.064
(b) 1970 percent "Spanish language"	.449	.155	.137
Ratio (a)/(b)	1.27	1.80	2.14
(U.S. Bureau of the Census, 1931 and 1971)			

Assuming some comparability of definitions, it is seen that the MA population of Imperial County has remained relatively stable, but has doubled for California. Thus, although waves of various types of migrants have come north from Mexico (many, in fact, through the county's border station), they have not altered the county's ethnic balance significantly in 40 years. Future importance of these migratory patterns, relative to energy development, will be discussed later.

Socioeconomic comparison of the MA with the Anglo population in 1970 reveals differences in spatial location, income, education, occupation, fertility, and age structure. All such differences have been previously noted for other regions (Bradshaw, 1973 and 1976; Grebler, et al., 1970; Uhlenberg, 1973). Table 17 gives the location of the major MA components in the county. This table accounts for 83 percent of MA's. The major geographical trend is the dominance of Calexico for MA's. Another important factor is the very high (81 percent) proportion MA in Heber. Since Heber is likely to be the first geothermal field developed, socioeconomic factors affecting the MA population will likely present themselves at a rather early stage in the valley's geothermal scenario.

The MA population dynamics for the county are based on a very high birth rate, combined with a very high outmigration of young persons. MA fertility is known to be the highest of any major ethnic group in the U.S. (Bradshaw, 1973; Grebler, 1970; Uhlenberg, 1973). In Imperial County MA completed fertility (or total average lifetime births to 1,000 women, 35-40, is 4,945 for MA's compared to 3,319 for Anglos, a difference of 49 percent (Table 20)). The net resultant of such a history of high fertility and high outmigration of young adults is a MA age structure of extreme youthfulness. Table 21 gives the 1970 age structures for the MA and Anglo segments of population. The sharp contrast is shown by average age, which is about 33 for Anglos and 19 for MA's.

About 27 percent of the MA population is age 0-9, and another 27 percent age 10-19. The influence of this youthfulness is pervasive--and serves to reinforce disparities in income and occupation. Unless altered, it will surely influence geothermal energy labor factors.

For income and education, there is marked contrast between the two ethnic groups. In Table 22 is shown income data for the county in 1970. The ratio of average income for Anglo families and unrelated individuals (adults) to that of MA's is 142 percent, and the income distributions are quite opposite. Similarly, in education, the differences are marked (Table 23). Only about 47 percent of MA's over age 25 are grade school graduates, compared to 86 percent of Anglos. These measures for both income and education largely control the age structure. The influence of the extremely youthful MA age distribution further increases the impact of these differentials.

In occupational distribution the MA population show an expected lag from that of the Anglo (Table 24). In order to accurately reflect the county work force, the green-card border commuters were redistributed to the occupational categories in accordance with available statistics. An average number of 9,000 (all classified males and MA) was assumed with 85 percent in farm occupations (U.S. Senate, 1971). Upon adjustment, the resultant

TABLE 20. COMPLETED FERTILITY^a BY ETHNIC GROUP

	<u>Imperial</u>	<u>Kern</u>	<u>Los Angeles</u>
MA	4,945	4,585	3,522
Anglo	3,319		

^aChildren born/1,000 women 35-40, ever married

Source: U.S. Bureau of the Census, 1971

TABLE 21. AGE STRUCTURE BY ETHNIC GROUP AND SEX
FOR IMPERIAL COUNTY, 1970

	Male			Female		
<u>Age Group</u>	<u>Number</u>	<u>Percent</u>		<u>Number</u>	<u>Percent</u>	
ANGLO						
-5	1,256	7.3	35.0	1,161	6.7	34.5
5-9	1,670	9.7		1,566	9.0	
10-19	3,074	18.0		3,268	18.8	
20-39	3,898	22.0	65.0	4,234	24.3	65.5
40-64	5,407	31.8		5,410	31.1	
65+	<u>1,839</u>	10.7		<u>1,763</u>	10.1	
	17,144			17,402		
MA						
-5	2,082	12.4	56.4	2,197	12.5	53.6
5-9	2,536	15.1		2,584	14.7	
10-19	4,814	28.9		4,625	26.4	
20-39	3,440	20.6	43.6	4,384	25.0	46.4
40-64	3,052	18.2		3,132	17.9	
65+	<u>808</u>	4.8		<u>606</u>	3.5	
	16,732			17,528		

TABLE 22. INCOME FOR FAMILIES AND UNRELATED INDIVIDUALS BY ETHNIC GROUP

<u>Income Class</u>	<u>Anglo</u>		<u>MA</u>		<u>Ratio of % Anglo/% MA</u>
	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>	
-1,000	283	2.7	230	3.4	79
1,000-2,999	740	7.0	737	10.9	64
3,000-4,999	1,109	10.6	1,284	19.0	56
5,000-6,999	1,245	11.9	1,391	20.7	57
7,000-8,999	1,458	13.9	1,098	16.2	86
9,000-11,999	1,952-	18.5	1,010	14.9	124
12,000-14,999	1,497	14.3	538	7.9	181
15,000-24,999	1,735	16.5	367	5.4	306
25,000-49,999	419	4.0	102	1.5	267
50,000+	58	.6	8	.1	600

	<u>Anglo</u>	<u>MA</u>	<u>Combined</u>	<u>Income Ratio Anglo/MA</u>
Number	10,496	6,765	17,261	
Average income	10,842	7,613	9,577	1.42

Source: U.S. Bureau of the Census, 1971

TABLE 23. EDUCATION BY SEX AND CATEGORY FOR IMPERIAL COUNTY,
1970, FOR PERSONS OF AGE 25+

	MA		Anglo	
	Male	Female	Male	Female
Percent grade school graduates	48.6	45.1	83.8	88.3
Percent high school graduates	25.8	20.4	52.6	57.0
Percent college graduates	2.8	1.9	12.1	8.5

Source: U.S. Bureau of the Census, 1971

**TABLE 24. OCCUPATIONAL DISTRIBUTION OF IMPERIAL COUNTY POPULATION BY
ETHNIC GROUP AND SEX FOR PERSONS AGE 16+**

	<u>MA</u>	<u>MA (Adjusted) *</u>	<u>Anglo</u>
<u>Male</u>			
Professional	4.6	1.8	11.4
Managers	8.7	3.4	16.5
Sales	5.3	2.4	6.0
Clerical	3.8	2.0	5.3
Craftsmen	12.4	6.6	20.7
Laborers and operatives	26.2	14.5	17.4
Farmers and farm managers	.6	.3	7.3
Farm laborers and foremen	30.2	63.4	7.2
Service	7.9	5.8	8.1
Private household	0.0	0.0	0.0
Total number	5,865	14,865	14,912
<u>Female</u>			
Professional	5.7		18.1
Managers	3.3		4.4
Sales	12.4		6.8
Clerical	27.7		39.4
Craftsmen	.7		1.1
Laborers and operatives	13.5		4.1
Farm workers	14.0		1.4
Service	16.3		21.2
Private household	6.4		3.5
Total number	2,702		5,380

* Border commuters redistributed

Source: U.S. Bureau of the Census, 1971

occupational contrast is striking--with 63 percent of the MA labor force farm laborers and foremen, compared to 7.2 percent for Anglos. By contrast, Anglo males were 39.2 percent in white collar occupations (professional, managerial, sales, clerical) compared to 9.6 percent for MA's. The two female distributions are more similar, but the farm element still differs significantly (34 percent for MA, 9 percent for Anglos). Another table (Table 25) compared the MA occupational spread for the three major cities in the county. The chief difference here is the reduced farm labor element in El Centro, in contrast to the other two towns. Such a reduction may reflect county differences in El Centro.

6B. Illegal Mexican Aliens

The entry of illegal aliens into a nation has always been of great concern to the government. In the case of the United States, the Immigration and Naturalization Service has historically devoted most of its efforts to the control of illegal entrants. In recent years the overwhelming majority of illegal entrants into the United States has been from Mexico. The consequences to Mexico and the United States are many.

To the extent that MA's are successful in entering and remaining in the United States and finding employment, the Mexican economy gains in two ways: persons are employed who would otherwise be a burden in their countries, and money is sent to Mexico from the United States by persons who would otherwise be unemployed.

For the United States the entrance of thousands of illegal aliens every year has many consequences. In the first place, it is costly. The annual budget for the Immigration and Naturalization Service in 1969 was \$89,699,300. This included support for the Border Patrol, which involves the services of several hundred officials and the maintenance of many offices, a training center, hundreds of vehicles including airplanes and boats, and costs of transporting aliens within the U.S. and abroad.

U.S. citizens who live in the border region and who lack sophisticated employment skills often look upon aliens as competition because they will work for less and they are a readily available source of labor. MA citizens and Mexican citizens who are legal resident aliens in the United States often have to compete with the illegal aliens for the unskilled employment available in the border region. This is true in agriculture, in many industries, in service employment, and in domestic employment.

The illegal entry of such large numbers of persons creates a series of problems in communities where they live (Samora, 1971). Housing is perhaps the most critical of these. The IMA has few choices as to where he will live and how much rent he will pay. The most primitive of accommodations are not unusual for these individuals, particularly those who work in agriculture. Since the great majority of the aliens are men and in the younger age group, problems characteristic of homeless men are common to them, such as delinquency and crime. Mexican and United States agencies working in public health, welfare, policy protection, narcotics, and many other fields have for years made joint efforts to solve these social problems.

TABLE 25. MAJOR MA OCCUPATIONAL GROUP IN MAJOR TOWNS

	<u>Brawley</u>	<u>El Centro</u>	<u>Calexico</u>
White collar ^a	43.4	48.6	50.8
Blue collar ^b	31.4	39.3	24.6
Farmers and farm managers	.3	.4	.8
Farm laborers and foremen	21.2	9.3	23.6
Private household	3.7	2.1	.2

^aProfessionals, managers, sales, clerical

^bCraftsmen, operatives, laborers, service

Persons who employ IMA's at minimal wages benefit from such labor. Since IMA's have no rights within the law, and since they can be turned in easily, some employers fail to pay the aliens before turning them in. Other employers, particularly in industry in the North, hire aliens at union wages.

Persons who traffic in human beings, the smugglers, have made the most profit from the illegal alien (Samora, 1971; Stoddard, 1976). The price for smuggling individuals has been high, the costs have been relatively low, and the penalties, if caught, until very recently, have been minimal and evidently well worth the risk.

A look at the illegal movement of people across the Mexican border, which was supposed to have been controlled by 1956, reveals, however, that there has been a steady increase from 1964 to the present time. Some persons, including officials of the Immigration and Naturalization Service, have suggested that the increase in IMA's is due to the elimination of the Bracero Program. There is some truth in this, but only up to a point. We have to remember that even in 1954, when the Bracero Program was in full swing, over a million IMA's were apprehended--the highest figure in history. Other reasons for the increase in the illegal traffic are suggested.

The two most compelling reasons for illegal immigration are the insatiable demand for cheap labor in the United States and the tremendous population increase occurring in Mexico. Mexico's population growth rate is among the highest in the world. Although Mexico's economic growth programs have made enormous strides, the economy has not been able to provide sufficient employment, schools, income, and services for the increasing population. While its food production is high, the availability of food for the poor is a problem.

As agribusiness in the U.S. becomes larger, the situation encourages a great demand for cheap and mobile labor force. The Bracero Program was just such a labor force and, additionally, it was partially subsidized by the federal government. IMA labor is even cheaper--no need for contracts, minimum wages, health benefits, housing transportation, etc. Since the workers are IMA's, they have few rights before the law and can be dismissed without notice.

A final reason for the increase in IMA movements is the fact that there are no great penalties involved in being an IMA nor in hiring an IMA. Both parties, employer and employee, can ignore legalities, the only serious consequence being an inconvenience to one party or both.

The above generalizations apply in various degrees to Imperial County. One fact is certain: the large number of IMA's present in the county. In 1975 there were approximately 50,000 apprehensions of IMA's in the county. This was determined by extrapolating earlier published figures in Samora (1971), using results of Dagodog (1975). One multiplier suggested by Samora for determining residents from one-year apprehensions is 3x. Since it is likely in the county's case that proportionately more IMA's are transients, one guess at IMA population would be to apply a multiplier of 1x, yielding a resident IMA population of 50,000.

6C. Interactions with Geothermal Energy Development

The county's MA population characteristics may interact with potential geothermal power development and industrialization. Since the county's chronic outmigration, a key question becomes whether or not future geothermal employment will tap the existent MA labor force and/or offer inducement for the MA young adults to remain in the county. If the above delineated educational gap remains in effect, it will likely be more difficult for a future MA geothermal employee to gain a job, compared to the average Anglo. Unless MA educational level increases, the skill requirements for employees in geothermal power plants and multipurpose industries will be critical in determining the extent of employment benefits to a future MA labor force.

Perhaps also the large size and sophistication of the corporations developing the energy and multipurpose use will reduce potential benefits to MA's. If a governmental policy were developed to favor very small businesses in, say, multipurpose use, perhaps more employment benefits would accrue to MA's.

In projections of future population of the county by ethnic composition, the key determinant will be the assumption of migration fluxes for Anglos and MA's. It is too speculative to predict relative advantages and disadvantages for young adults to remain in the county 20 or more years in the future, when large-scale power plants and geothermal industries will likely be present.

Another unknown factor is the shape of future immigration legalities and enforcement procedures. Judging by a volatile past history of regulatory shifts, there will be future changes, but these are impossible to predict, as they involve U.S. economic health, foreign policy, technological factors in agriculture, etc.

7. Regional Employment Implications for Geothermal Energy Development

In this section of the report, analyses are done related to employment in the county: (1) a land area analysis and projection of farm labor displacement from the installation of a geothermal power capacity, based on geographical research of Johnson, et al. (1976); and (2) a regression analysis of broad unemployment variables, using 1970 Census ED data. These studies may be regarded as complementary. Farm labor displacement estimation technique, based on labor multipliers of land areas, is simpler and more direct than regression analysis, but has several sources of error, including farm labor productivity increases, future county water and crop patterns, and possible geothermal unknowns such as subsidence. The regression analysis investigates effects of socioeconomic characteristics of the unemployed. The population sampled is occupationally only 14.0 percent farm laborers on the average (Table 30), since border commuters are excluded. Hence, results of the regressions apply mostly to white collar and blue collar occupations. Regression analysis reveals greater subtlety in employment trends than the farm labor analysis. Implications of the regressions are applied to several aspects of prospective geothermal development, including nonelectrical employment.

Sources of error in the regression analysis include statistical sampling errors, a sample year--1970--the results from which may not apply as geothermal plant capacity is scaled up in the 1980's and 1990's, and errors in inferring present and future causation.

7A. Farm Labor Force Reduction Based on Land Area Analysis

The reduction, from geothermal development, of the farm laborer category in the Imperial County labor force was estimated based on prior studies of geothermal capacity (Davis, 1976), crop acreage (Johnson, et al., 1976) and power plant impact (Sheehan, et al., 1976). This analysis is based on the following schema for land reduction at one power plant site.

It is assumed that a 100 mW power plant installation will consume 10 acres (i.e., remove 10 acres from agricultural use by either direct or indirect effects) for the immediate area that the central power plant is sited on and the right of way for the central power plant. It is assumed that for the 100 mW capacity, there are 20 production wells and 12 reinjection wells. Each well is assumed to be spaced over 20 acres. The total well-spacing is thus assumed over 640 acres (slant drilling will be discussed below). The key question is then how much of the 640 acres is consumed either by well

pads, pipelines, right-of-way, subsidence problems (this will likely be small due to an assumed strong public policy against subsidence), and other environmental and agricultural causes. There are so many regulatory, agricultural, and geologic unknowns in the above causes that the present analysis simplified matters by assuming three possible percentages of land reduction for the well-spacing area (i.e., the 640 acres/100 mW capacity): (1) 5 percent, (2) 10 percent, and (3) 35 percent. These reductions are henceforth referred to as interstitial land reductions.

For the case of slant drilling, land is still consumed by centralized well pads, pipelines and right-of-way (albeit less), subsidence, and environmental-agricultural causes. Thus for slant drilling one should choose a smaller percentage reduction based on the partial land-consumption benefits of this method. Nevertheless, some land will still be consumed.

Calculations

The calculations of farm labor reduction are given in Tables 26 and 27. Two types of crop coverage are assumed for displaced KGRA acreage--an average 100 acres and all field crops. Table 26 presents the computations for an average 100 acres of crops as defined in a separate report by Sheehan, et al. (1976). For each KGRA a manpower reduction (in man-year units) is assumed based on the above report. Also, a scenario of power plant capacity is assumed for each KGRA based on the medium estimate of Davis (1976). The KGRA's are then summed in the right-hand columns to give total farm labor displaced for the county. Table 27 gives the number of laborers displaced by interstitial land reduction, farm income, KGRA, and year for field crop areas.

Results

The general county results are given in Table 29. It is seen that the maximal reduction in labor force (year 2020, 35 percent i.l.r., average crops, \$4,000 income) is 187 laborers, assuming the fixed agricultural mechanization and other trends. Based on a present labor force (including border commuters) of 15,000, this is a reduction of only 1.24 percent. Since it is likely that the county will increase in population (Pick, 1976), this percentage may be reduced by 50 percent based on year 2020 populations. The 5 percent i.l.r. for the other above assumptions unchanged yields a farm labor reduction of only 27 laborers or .18 percent based on 1970 population. For the case of all field crops, the figures are roughly 75 per cent less than for average crops.

7B. Regional Regression Analysis for Employment

Demographers, economists, and sociologists have for years advised that more new industry should be located in areas of rural underemployment. They claim that new industries will increase the utilization of local labor supply, thereby reducing unemployment. Yet examination of employment by industry in

TABLE 26. FARM LABOR FORCE DISPLACEMENT BY KGRA, PLANT CAPACITY, FARM WORKER INCOME, AND LAND REDUCTION FOR AVERAGE 100 ACRES

KGRA													
		Salton Sea			Brawley			Heber			Total		
Year		Capacity ¹	FLD5	FLD4	Capacity	FLD5	FLD4	Capacity	FLD5	FLD4	Capacity	FLD5	FLD4
5% i.l.r.	1980	90	.51	.64	35	.18	.22	35	.66	.83	180	1.35	1.69
	1990	250	1.42	1.77	100	.51	.64	100	1.89	2.36	500	4.77	5.97
	2000	1,250	7.16	8.95	500	2.55	3.19	500	9.47	11.84	2,500	19.18	23.97
	2010	1,750	10.02	12.52	700	3.57	4.46	700	13.25	16.56	3,500	26.84	33.55
	2020	1,750	10.02	12.52	700	3.57	4.46	700	13.25	16.56	3,500	26.84	33.55
10% i.l.r.	1980	90	.91	1.14	35	.31	.39	35	1.17	1.46	180	2.39	2.99
	1990	250	2.52	3.15	100	.90	1.12	100	3.33	4.17	500	6.75	8.44
	2000	1,250	12.62	15.77	500	4.49	5.62	500	16.68	20.85	2,500	33.79	42.24
	2010	1,750	17.66	22.07	700	6.30	7.87	700	23.35	29.19	3,500	47.31	59.14
	2020	1,750	17.66	22.07	700	6.30	7.87	700	23.35	29.19	3,500	47.31	59.14
35% i.l.r.	1980	90	2.87	3.59	35	.99	1.24	35	3.69	4.61	180	7.55	9.44
	1990	250	7.98	9.97	100	2.84	3.56	100	13.18	16.48	500	24.00	30.00
	2000	1,250	39.90	49.87	500	17.78	22.23	500	52.74	65.93	2,500	110.42	138.02
	2010	1,750	55.85	69.82	700	19.92	24.90	700	73.84	92.30	3,500	149.61	187.01
	2020	1,750	55.85	69.82	700	19.92	24.90	700	73.84	92.30	3,500	149.61	187.01

i.l.r. = interstitial land reduction

FLD5 = farm labor displacement (average annual income = 5,000)

FLD4 = farm labor displacement (average annual income = 4,000)

¹All capacity figures in mW

TABLE 27. FARM LABOR FORCE DISPLACEMENT BY KGRA, PLANT CAPACITY, FARM WORKER INCOME, AND LAND REDUCTION FOR FIELD CROPS

KGRA													
Salton Sea				Brawley			Heber			Total			
	Year	Capacity ¹	FLD5	FLD4	Capacity	FLD5	FLD4	Capacity	FLD5	FLD4	Capacity	FLD5	FLD4
5% i.l.r.	1980	90	.23	.29	35	.07	.08	35	.07	.08	180	.37	.46
	1990	250	.64	.80	100	.19	.24	100	.19	.24	500	1.02	1.27
	2000	1,250	3.20	4.00	500	.96	1.20	500	.97	1.21	2,500	5.13	6.41
	2010	1,750	4.48	5.61	700	1.34	1.67	700	1.36	1.70	3,500	7.18	8.97
	2020	1,750	4.48	5.61	700	1.34	1.67	700	1.36	1.70	3,500	7.18	8.97
10% i.l.r.	1980	90	.41	.51	35	.12	.15	35	.12	.15	180	.65	.81
	1990	250	1.13	1.41	100	.34	1.42	100	.34	.42	500	1.81	2.26
	2000	1,250	5.66	7.07	500	1.68	2.10	500	1.71	2.14	2,500	9.05	11.31
	2010	1,750	7.92	9.90	700	2.36	2.95	700	2.40	3.00	2,500	12.68	15.85
	2020	1,750	7.92	9.90	700	2.36	2.95	700	2.40	3.00	3,500	12.68	15.85
35% i.l.r.	1980	90	1.29	1.61	35	.37	.46	35	.38	.47	180	2.04	2.55
	1990	250	3.58	4.47	100	1.06	1.32	100	1.08	1.35	500	5.72	7.15
	2000	1,250	17.88	22.35	500	5.32	6.65	500	5.41	6.76	2,500	28.61	35.76
	2010	1,750	25.04	31.30	700	7.45	9.37	700	7.57	9.46	3,500	40.06	50.07
	2020	1,750	25.04	31.30	700	7.45	9.37	700	7.57	9.46	3,500	40.06	50.07

i.l.r. = interstitial land reduction

FLD5 = farm labor displacement (average annual income = 5,000)

FLD4 = farm labor displacement (average annual income = 4,000)

¹All capacity figures in mW

TABLE 28. POVERTY AND UNEMPLOYMENT BY ETHNIC GROUP
FOR IMPERIAL COUNTY, 1970

	<u>MA</u>	<u>Anglo</u>
Poverty ^a	25.5	10.0
Male unemployment ^b	9.6	5.9
Female unemployment ^c	8.2	5.5

^aPercent of families below poverty level

^bPercent of males, age 16+, in labor force and unemployed

^cPercent of females, age 16+, in labor force and unemployed

Source: U.S. Bureau of the Census, 1971

TABLE 29. AGRICULTURAL LABOR FORCE REDUCTION FROM
GEOTHERMAL DEVELOPMENT--JPL SCENARIO

	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>
5% i.l.r., field, M, \$5,000	.37	1.02	5.13	7.18	7.18
5% i.l.r., field, M, \$4,000	.46	1.27	6.41	8.97	8.97
10% i.l.r., field, M, \$5,000	.65	1.81	9.05	12.68	12.68
10% i.l.r., field, M, \$4,000	.81	2.26	11.31	15.85	15.85
35% i.l.r., field, M, \$5,000	2.04	5.72	28.61	40.06	40.06
35% i.l.r., field, M, \$4,000	2.55	7.15	35.76	50.07	50.07
<hr/>					
5% i.l.r., aver., M, \$5,000	1.35	4.77	19.18	26.84	26.84
5% i.l.r., aver., M, \$4,000	1.69	5.97	23.97	33.55	33.55
10% i.l.r., aver., M, \$5,000	2.39	6.75	33.79	47.31	47.31
10% i.l.r., aver., M, \$4,000	2.99	8.44	42.24	59.14	59.14
35% i.l.r., aver., M, \$5,000	7.55	24.00	110.42	149.61	149.61
35% i.l.r., aver., M, \$4,000	9.44	30.00	138.02	187.01	187.01

i.l.r. = interstitial land reduction

field = all field crops

aver. = average crop distribution (Sheehan, 1976)

M = middle Cal Tech Scenario

dollar values = income figures for farmworkers

the various labor markets shows a wide difference in the types of industries that are located in specific communities (Hunter, Reid and Boddy, 1970).

This section of the report is concerned with local labor market analysis. Its main focus is on employment and associated local labor market effects of geothermal development in Imperial County. The section will first discuss available historical evidence from similar past research and will then examine studies relating to the prospect of geothermal development in Imperial County. Next it will discuss regression findings of U.S. Census statistics on the county, in order to understand its socioeconomic characteristics, and to project potential employment effects of geothermal development. Finally, the applicability and potential usefulness of regression results to prospective geothermal development will be addressed.

The present research is not addressed to total county employment shifts, but rather to an analysis of intracounty subregional (ED) differentials in employment. The basis in demographic theory for such a study may be found in regional studies of vital rates (Heer, 1970; Biggar and Butler, 1969; Melvin-Howe, 1968; DeSandre, 1971; Pick, 1976), overcrowding-isolation (Galle *et al.*, 1974), female labor force participation (Collver and Langlois, 1962; Collver, 1968), male labor force participation (Baer, 1972), employment (Sweet, 1972), and others. These studies compare regions based on the methods of correlation and multivariate analysis. In demography, regression analysis shows similarity between effects of a group of independent variables, which are often population and socioeconomic characteristics, and a dependent variable, such as those in the above-cited studies. Regression analysis has the weaknesses of sampling inaccuracies, spurious correlations, nonorthogonality of independent variables, a normality assumption for the distribution of residuals, etc. However, results of such studies are useful to the demographer, if treated cautiously, with each of the above drawbacks in mind.

A design close to that of the present study was employed in a regression analysis of fertility by Heer and Boynton (1970). The sample consisted of 591 U.S. counties in 1960, with a sampling ratio of .188--close to that in the present research. The dependent variable chosen was a type of standardized fertility ratio, and the independent variables, in order of importance to the regression, included percent Roman Catholic (positive effect), a density index (negative), percent nonwhite (positive), and infant mortality (positive). The importance of percent Catholic was interpreted to result from both child preference ideals and contraceptive practice.

Baer (1972) performed a stepwise regression analysis of seven age-specific male labor force participation rates. These dependent variables were each defined as the number of males in the civilian age-specific labor force over the male noninstitutional age-specific population. Independent variables consisted of a mixture of age-aggregated and age-specific measures, including age-specific migration, age-specific percent in the military, ratio of age group to total population, median earnings of labor force males, education of males 25+ years, and male unemployment for the whole labor force. For most age groups, significant positive relationships were obtained for education and earnings, and inverse results were obtained for unemployment--the latter validating the "discouraged worker theory," in which worker discouragement in the face of high unemployment is postulated to reduce participation in the work force.

For sizable geographical areas (above, say, average U.S. county size) female labor force participation has been shown to have been nearly always lower than for males, most likely due to childbearing and family alternatives of women. In an international comparison, Collver and Langlois (1962) give such figures for labor force participation (defined as the ratio of number of people in the labor force to number of people 15-64) as .48 for France in 1954, .37 for the U.S. in 1950, .54 for Jamaica in 1953, and .12 for Egypt in 1947. Since the date of this study these figures have risen in many countries. For comparison, female participation, as defined above, is .484 for California in 1970, and .388 for Imperial County in 1970. Collver, *et al.* divided their sample of 38 nations into three economic development stages. They discovered that female participation rates did not correlate with these categories, but rather were related to the following four nation types, which cut across the categories: metropolitan, "Latin American," "Caribbean," and "early marriage and female seclusion." The relationship of female labor force participation to industrial composition was investigated, as well as the relationship to fertility. The latter was shown to have a strong inverse correlation. Collver (1968) pursued the latter fertility relationship by an investigation based on a sample of 65 U.S. Standard Metropolitan Statistical Areas in 1960. The 1968 results strongly confirm the prior negative correlation: he gives correlations of percent of women in the labor force to children under 5 per woman of $-.85$ for whites (ages 20-24) and of $-.32$ for nonwhites (20-24). In a short discussion of possible cause and effect, Collver is inclined toward the interpretation that high work participation causes low fertility.

In a regional multivariate study, Sweet (1972) used the 1/1000 sample from the 1960 Census to study differences in employment of rural farm wives. He used the dummy regression method of multiple classification analysis, which reveals effects of individual independent variables. Results show effects on rural farm wife employment for such variables as southern location (positive), metropolitan county (positive), age range 20-39 (positive), Spanish American (negative), elementary school education (negative), high income (negative), young children under 5 (negative), blue collar occupation (positive), and wage and salary income only (negative). All the major results were readily interpreted, and were shown to correspond closely to results for urban women.

There are few studies relating to application of employment statistics to rural industrialization. One such study (Gray, 1969) relates to the following important question that can be raised in connection with employment effects of industrial change--When a plant actually does locate in a rural area, who will be employed?

When geothermal industries are established in Imperial Valley, employment opportunities may not open up for local workers. If the industry is capital-intensive, employment may be available only for skilled workers. But if the local unemployed workers do not possess the requisite job skills--which is likely--there will be few employment opportunities available. This would mean, of course, that the industry would bring in most of its workers from outside areas, thus leaving the local unemployed unaffected. Although additional peripheral jobs are created by the location of an industry, they may well be in the service or professional categories.

This point is substantiated by the Gray study. In 1956, an aluminum reduction and rolling mill was built by the Kaiser Aluminum and Chemical Company at Ravenswood, West Virginia, a small town located in a depressed agricultural area of the state. A decline in agricultural activities had caused a general outmigration from the area. As the Kaiser plant went into operation, an effort was made to give first hiring priority to workers from the Ravenswood area. This proved unsuccessful, for it was discovered that the local workers did not possess the requisite job skills. Even though standards were relaxed, the qualifications of most of the unemployed and underemployed workers fell far short of those necessary to obtain employment, and most of the workers had to be imported from areas outside the state. As the plant increased its operation, skill requirements also increased, and unskilled workers were gradually replaced. Although some 4,000 workers were employed at the plant, only 300-500 of them came from the local area. Some of these had moved from the area, had acquired skills, and had returned home when the plant started operations. Moreover, the secondary effects on employment were also disappointing. Although a number of additional jobs were created in Ravenswood, those that required any degree of skill also were filled by outsiders.

Methodology -- Sample Characteristics

As in sections 4 and 5, data was obtained for Imperial County from the fifth count of the 1970 Census (U.S. Census, 1974). This sample data is divided into 80 ED's (i.e., enumeration districts), which vary in size from 88 to 2,261 persons. For the correlation and regression analysis, the sample is split into two subsamples--geothermal and nongeothermal in the manner detailed for the discriminant analysis in section 5A. The reader is again referred to FIGURE 5, a detailed map showing major towns and ED-KCRA boundary superimpositions. The above classification method results in 48 geothermal ED's and 32 nongeothermal ED's. There is fairly strong similarity in these classes to urban-rural categories, as geothermal ED's are 87.5 percent urban and nongeothermal ones are 68.7 percent rural.

An important factor underlying this sample design is the independence of the county's economy of adjacent counties, so that it may be considered to form one U.S. labor pool. As part of the present NSF project, an input-output matrix was constructed (Lofting and Rose, 1976) for the entire county in 1972, and the matrix was projected for 50 years with a geothermal element added.

From the results of the aggregated 25-sector input-output matrix, it would appear difficult to study intercounty implications of employment in the case of Imperial County. Total imports included in total final demand in the 1972 input-output flow table are 41.43 percent agriculture-related; foreign exports included in gross output are 47.15 percent agriculture-related; and other exports included in gross output are 72.87 percent agriculture-related.

Imperial County's economy is not, in large part, tied to neighboring counties, but rather to a national and international agricultural distribution network governed by rather unpredictable commodity markets, and so the present study does not attempt to examine intercounty interactions. Rather, the implications of the present research findings would appear to be methodological for

other geothermal regions. Many areas of the western United States contain large geothermal fields, but only one (Sonoma County, California) has been developed so far. Thus the rationale and methodology (including use of the ED data) may prove of benefit to other anticipated noncounty regional studies. If such future studies will have the benefit of regional retrospective energy data, they will reach more powerful conclusions than the current prospective study.

An exceptional feature to the county economy's independence of its neighbors is the economic and labor force association with Mexico, previously covered in sections 1 and 6. Since no detailed socioeconomic information is available on border commuters or on other border economic interactions, the only choice is to regard border effects as a source of error in considering the county as one labor pool.

In the present design, sample populations are determined by place of residence rather than by place of work. The latter might be preferable if the analysis were intended to emphasize characteristics of workers as groups in businesses and public sector work places. However, not only is data on work place unavailable at the subcounty level, but also the regional socioeconomic characteristics of unemployed persons may well be more meaningful in terms of similar residential locations, for which social identities may be stronger than for job locations. In terms of application of this study to energy development, residential groups of unemployed may be more important, because businesses plan their prospective work forces at new locations on the basis of commuting distance for the worker from his residence (Fulton, 1974).

The rationale behind the division of the sample into geothermal and nongeothermal subsamples is the following: certain effects from geothermal energy development will be concentrated on persons in proximity to the geothermal fields. Examples are hydrogen sulfide emissions and noise pollution from geothermal power plants, dangers from well blow-outs, and nonelectrical uses of the energy. The latter include use of the hot water brought up to the surface for house heating, air conditioning, food processing, ground warming, extraction of chemicals, and balenology. Since there is a limit on transport of hot water for nonelectrical uses of perhaps 50 km, the subsample of geothermal ED's almost certainly will include land areas residentially closer to such uses. Results of the regression analysis for this subsample may be cautiously utilized in assessing nonelectrical employment opportunities--cautiously for the following reasons: (1) skill requirements for nonelectrical industry may override proximity in establishment of labor pools, (2) in future energy development, areas adjacent to geothermal fields may be altered by immigration or outmigration, and (3) sampling in the regression analysis of only one annual and seasonal timepoint may not apply to later populations even with minimal migration change.

Variables

The 33 independent variables, which are listed in Table 30, were carefully selected using the following selection criteria: [1] variables of direct economic importance to unemployment (variables 10-12, 18-31 in Table 30), [2] intermediate variables found to have been of importance in prior U.S. regional

Table 30. Means and Coefficients of Variation for Independent Variables

Variables	Entire		Geothermal		Non-Geothermal		Calif. ^a
	Mean	Coeff. Var.	Mean	Coeff. Var.	Mean	Coeff. Var.	
1. P.†† Spanish Am.	.455	.606	.541	.568	.323	.456	.137
2. Dep. Ratio	.957	.258	.952	.291	.964	.205	.606
3. White Fert. Ratio	.465	.391	.457	.339	.477	.456	.378
4. Span. Fert. Ratio	.646	.669	.535	.580	.812	.655	.528
5. P. Now Married	.613	.106	.601	.121	.631	.074	.595
6. P. Diff. House 1965	.549	.250	.547	.246	.552	.260	.434
7. P. Diff. County 1965	.107	1.025	.092	.700	.130	1.179	.200
8. P. Diff. State 1965	.075	1.485	.084	1.441	.062	1.551	.092
9. P. Abroad 1965	.051	2.115	.061	2.207	.035	.955	.025
10. P. White Collar	.432	.428	.444	.446	.413	.398	.550
11. P. Blue Collar	.428	.404	.425	.399	.433	.418	.435
12. P. Farm Worker	.140	.974	.132	1.115	.154	.790	.015
13. Density A*	.577	.266	.547	.264	.623	.254	.672
14. Density B** (Anglo)	.807	.137	.794	.161	.826	.093	.920 ^b
15. Density B (Span. Am.)	.632	.282	.646	.303	.611	.243	
16. P. Utility Gas	.519	.535	.649	.307	.325	.823	.859
17. P. Bottled Gas	.098	1.597	.041	1.656	.182	1.135	.031
18. P. Electricity	.315	.628	.257	.677	.402	.503	.086
19. P. Rentals 0-99	.405	.574	.403	.644	.408	.462	.400
20. p. Rentals 100-149	.426	.420	.399	.404	.465	.427	.365
21. P. Rentals 150+	.144	1.074	.166	1.034	.110	1.072	.234
22. P. Income 0-3.9†	.194	.751	.189	.754	.201	.756	.265
23. P. Income 4-9.9†	.431	.350	.431	.362	.432	.336	.328
24. P. Income 10-24.9†	.372	.597	.376	.636	.365	.539	.407
25. P. Below Poverty	.169	.803	.180	.773	.152	.858	.084
26. P. House Value 0-9.9†	.290	.855	.252	.873	.348	.803	.047
27. P. House Value 25+†	.074	1.779	.081	1.799	.063	1.712	.412
28. P. Spanish Tenure	.506	.549	.539	.482	.458	.658	.549 ^c
29. P. House Built 1965-70	.131	1.765	.137	1.346	.122	.721	.135
30. P. House Built 1960-65	.129	1.015	.125	.982	.136	1.066	.178
31. P. House Built -1965	.727	.339	.737	.351	.711	.323	.687
32. P. Elem. Educ.	.299	.711	.308	.736	.285	.674	.258
33. P. H.S. Educ.	.469	.323	.443	.328	.508	.305	.549

* 3 or less persons per unit

** 1 or less person per room

† in thousands

†† percent

a. Statewide crude statistics from U.S. Census (1973)

b. Density B for the entire population

c. Tenure for the entire population

Sources: U.S. Census (1973, 1974)

population studies (such as Baer, 1972; Biggar, *et al.*, 1969; Collver, 1968; Galle, *et al.*, 1973; Galle, *et al.*, 1974; Heer, *et al.*, 1970; Levine, 1957; Pick, 1976; Sweet, 1972), such as density, fertility, and mobility variables (variables 2, 3, 6-9, 13-15, 32, 33), and [3] an ethnic variable (percent Spanish speaking), dependency ratio and utility variables (variables 1, 2, 16-18), which were of critical importance in Sections 3-5.

All definitions of variables which are unusual or defined in several ways in the literature are clarified below, using the above threefold classification of variables: [1] white collar (variable 10) comprises the occupational categories professional workers, farmers and farm managers, other managers, clerical workers, and sales workers. Blue collar (11) comprises the categories craftsmen, operatives, and service workers. Rentals (19-21) is the proportion of number of renter-occupied monthly gross rents of a certain value to all renter-occupied units. Income (22-24) is for families and unrelated individuals 14 years and older. Poverty (25) is the proportion of families below poverty level to all families. Spanish tenure (28) refers to the ratio of Spanish American owner-occupied housing units to all Spanish American occupied housing units. (Henceforth Spanish American is abbreviated as SA.) Structural history of housing (29-31) is the ratio of year-round housing units built in certain periods to total year-round housing units. [2] Fertility ratios (3, 4) refer to the ratio persons under 5/females 15-45. Mobility indices (6-9) refer to the proportion of 1970 population 5 years and older of a certain mobility state in 1965 to all persons 5 years and older in 1970. Education variables (32, 33) are proportions in the population 25+ years. [3] Percent SA (1) is defined as the ratio (persons of Spanish language or surname)/all persons. Dependency ratio (2) is defined as (persons under 18 plus persons 65 and over)/persons 18-64. Percent now married (5) is the ratio of presently married persons 14+ to total population 14+. The utility variables (16-18) refer to the proportion (particular fuel type in occupied housing units)/all occupied housing units.

Twelve dependent variables were selected and are given in Table 31. The rationale for choice of these is as follows. Imperial County has an unusual age structure. Forty-five percent of males and 44.3 percent of females are below age 20, compared to respective California figures of 38.2 percent and 35.6 percent. Also, the county historically has had high sex ratios (1.19 in 1950 and 1.24 in 1960), although these dropped to .98 in 1970. These sex ratios, combined with sharp outmigration in young adult age groups, have caused a highly irregular county population pyramid (FIGURE 1). Another irregularity is the very sharp difference between the SA and white pyramids: 54.9 percent of the SA population is under 20, compared to 34.7 percent for whites. To assess the broad age-structural forces of unemployment, three related unemployment variables were chosen. The first, henceforth referred to as age-eligibility (variables 34-37 in Table 31), is the ratio (pop. 16+)/total population, which indicates the segment of the total encompassed by the labor pool. The strict Census definition of labor pool, which includes all aged persons, was adhered to in this study, because employed aged persons are counted by the Census. For the analysis, age eligibility was categorized separately by sex and by ethnic category. The reason for twice dividing the entire variable into two categories rather than dividing it into four subcategories, such as SA male, was to avoid statistical

Table 31. Means and Coefficients of Variation for Dependent Variables

Variables	Entire		Geothermal		Non-Geothermal		Calif.
	Coeff.		Coeff.		Coeff.		
	Mean	Var.	Mean	Var.	Mean	Var.	
34. Age Eligibility (male)	.640	.171	.621	.148	.669	.189	.693
35. Age Eligibility (female)	.651	.143	.633	.117	.677	.166	.713
36. Age Eligibility (Sp. Am.)	.553	.188	.560	.175	.544	.172	.604
37. Age Eligibility (white)	.645	.150	.624	.123	.675	.209	.709
38. L. Force Partic. (male)	.721	.228	.760	.150	.661	.315	.767
39. L. Force Partic. (female)	.358	.380	.373	.341	.335	.439	.421
40. L. Force Partic. (Sp. Am.)	.495	.401	.546	.235	.418	.255	.583
41. L. Force Partic. (white)	.532	.246	.555	.196	.497	.310	.567
42. Unemployment (male)	.081	.897	.079	.724	.084	1.097	.043
43. Unemployment (female)	.061	1.074	.058	.918	.066	1.240	.029
44. Unemployment (Sp. Am.)	.071	1.035	.061	1.283	.077	.903	.046
45. Unemployment (white)	.072	.802	.071	.701	.075	.930	.034

Sources: U.S. Census (1973, 1974)

error from additional halving of sample units, and to allow broader comparisons by sex and ethnic group.

Labor force participation variables (38-41) are defined as civilian labor force/all persons 16+. These introduce the small error of inclusion of military personnel in the denominator, but not in the numerator. This error is justified because the military category is not a subject of the analysis--the military is assumed independent of geothermal effects. The above exclusion allows the three sets of dependent variables to multiply to the ratio of unemployed to total population. A third set of dependent variables for unemployment (42-45) is defined in the standard manner as unemployed persons/labor force.

Major differences between geothermal and nongeothermal areas include lower percent SA in the nongeothermal region, higher SA fertility ratio, higher county mobility, lower state and international mobility, and a utility house heating mix with greater use of bottled gas and electricity (32 percent utility gas, 18 percent bottled gas, 40 percent electricity, and 10 percent other). This fertility difference, although it is for only two regions, would correspond to nationwide results in Pick (1976), which show significant inverse relationship between nonwhite fertility and percent nonwhite.

Values for the dependent variables (Table 31) show lower age eligibility than for California--a reflection of the younger county pyramid, lower age eligibility for SA compared to whites, labor force participation for males approximately twice than for females (a standard result--see Collver, 1968), lower county work participation than for the state, higher unemployment for males than for females, and for SA's than for whites, and significantly higher unemployment for all categories for the state. The latter difference, in general, may be due to a tighter labor market in the county, and is discussed in greater detail later with the regression results.

Results

After preparation of the data with the authors' sorting and tabulation computer programs, correlation and stepwise regression analysis was performed by a standard routine BMDP-02R (Dixon, 1976). Values for the independent variables (Table 30) reveal most of the important socioeconomic features of the county, which were covered in detail in a prior study (Pick, et al., 1976). Perhaps the most important feature is the large SA segment of the population--45 percent for the average ED. County fertility is 22 percent higher than for the state for both ethnic groups, and is 38.9 percent higher for SA than for whites. Other variables significantly different from statewide trends are mobility, which is higher for household and international and lower for county and state, utilities, which are higher for electrical and lower for gas heating, and poverty and housing, which reveal greater poverty and lower housing values than for California.

Correlations among the independent variables for the entire sample reveal several pivotal variables which are highly correlated with the others--percent SA, percent white collar, and white room density of 1 or less. There is a positive correlation ($r = .447$) between SA and dependency ratio--reflecting higher SA fertility. Percent SA has a negative relationship

($r = -.612$) with percent now married, a result also of the significant younger SA age structure. SA predominance in farm labor category is reflected by a correlation of the two of .476.

SA population and income levels are strongly inversely related ($r[\% \text{ SA, } \% \text{ below poverty}] = .620$ and $r[\% \text{ SA, } \% \text{ income } \$10,000-24,900] = -.508$), and the same type of effect holds for education ($r[\% \text{ SA, } \% \text{ elem. school educ.}] = .624$, $r[\% \text{ SA, } \% \text{ high school educ.}] = -.635$). All the above SA correlations remain strong, but reversed in sign if percent white collar or percent room density 1 or less is substituted for percent SA. This reversal is not surprising for percent white collar, as Imperial County has an occupational structure with proportionately more whites in the higher categories. However, the reversal with white density is surprising, and is surely due to more than mere economics of house sizes. The density variables are important for the age eligibility regressions, and are discussed further below.

The groups of independent variables show strong positive group intercorrelations; except for unemployment there is a strong inverse correlation ($r = -.383$) between male and female unemployment--a result of differing social forces on the two, as revealed by highly different regression results for unemployment by sex. For males, there are directional reversals on correlations for the three dependent variables: r (age eligibility, participation) = $-.498$, r (participation, unemployment) = $-.367$, and r (age eligibility, unemployment) = $.519$. This sequence underscores the difficulty in analyzing broadly unemployment relative to age structure--favorable age eligibility is related to poor work force participation, which in turn is related to high unemployment. The above pattern also holds to a lesser extent for whites.

Results of the regression analysis for the three samples are presented in Tables 32-34. For the entire county, age eligibility is strongly positively related to housing densities and strongly inversely related to fertility. This effect would appear to reflect a composite of demographic forces in the county--high fertility, a resultant large population proportion of children and adolescents, and consequent high housing densities. The positive effect of fertility for females and SA's (versus little or no effect for males and whites) may reflect lower ED mobility, resulting in more stable ED fertility characteristics. Nineteen-seventy SA household and county mobility values are .402 and .081, versus .453 and .221 for non-SA's (U.S. Bureau of the Census, 1973). The argument that stability of residential location leads to more accurate measurement of period fertility (and mortality also) was used to justify a national study of vital rates (Pick, 1976). This residential stability is even more necessary in the present case for fertility to cause age eligibility changes, since to do so, the following line of reasoning is necessary: (1) present fertility in an ED is assumed highly correlated with the past birth sequence in an ED; (2) low mobility implies that the fewer babies born survived as ED residents; and (3) in a system more closed to migration, fewer past births would result in an older age structure by well-known population mathematics results.

For the geothermal sample, the above conclusions again hold, with the addition of several economic results. For males high income has a significant positive effect on age eligibility. Imperial County is estimated to have

Table 32. Beta Coefficients, Multiple Correlation Coefficients and Percent of Variance Explained by Selected Enumeration District Characteristics for Dependent Variables, Geothermal Sample

Variables	Age Eligibility				Labor Force Participation				Unemployment			
	M	F	W	SA	M	F	W	SA	M	F	W	SA
P. Spanish Am.												
Dep. Ratio												
White Fert. Ratio			-.299 ²						.309 ¹	-.280		
Span. Fert. Ratio				-.442 ⁴						.428 ²	.347 ²	.511 ⁴
P. Now Married												
P. Diff. House 1965		-.312 ²									.303 ²	.300
P. Diff. County 1965												-.442 ²
P. Diff. State 1965												
P. Abroad 1965												
P. White Collar												
P. Blue Collar												
P. Farm Worker	.486 ⁴				.292 ¹							
Density A*	.668 ⁴	.760 ⁴	.772 ⁴	.523 ⁴								
Density B** (Anglo)				-.461 ²								
Density B (Span. Am.)				.480 ⁴								
P. Utility Gas											.398 ²	
P. Bottled Gas		-.206	-.228 ¹								.540 ⁴	
P. Electricity						.481 ⁴		-.662 ⁴				
P. Rentals 0-99†												
P. Rentals 100-149†												
P. Rentals 150+†												
P. Income 0-3.9†						-.481 ²						
P. Income 4-9.9†		-.412 ⁴	-.270 ²									
P. Income 10-24.9†	.528 ⁴											
P. Below Poverty					-.453 ⁴		-.692 ⁴		.349 ¹			
P. House Value 0-9.9†												
P. House Value 25+												
P. Span. Tenure				.264								
P. House Built 1965-70					.258 ²		.271 ²					
P. House Built 1960-65								-.203				
P. House Built -1965												
P. Elem. Educ.						.283	.370					
P. H.S. Educ.						.453 ²	.243					
Multiple Correlation Coefficient	.790 ⁴	.801 ⁴	.832 ⁴	.829 ⁴	.820 ⁴	.701 ⁴	.836 ⁴	.810 ⁴	.534 ³	.452 ²	.681 ⁴	.635 ⁴
P. of Variance Explained (R ²)	.623	.641	.692	.687	.672	.492	.670	.656	.285	.204	.463	.403

* 3 or less persons per unit

** 1 or less person per room

† in thousands

Levels of significance:

¹ = 0.025

² = 0.01

³ = 0.001

⁴ = 0.0005

Table 33. Beta Coefficients, Multiple Correlation Coefficients and Percent of Variance Explained by Selected Enumeration District Characteristics for Dependent Variables, Entire Sample

Variables	Age Eligibility				Labor Force Participation				Unemployment			
	M	F	W	SA	M	F	W	SA	M	F	W	SA
P. Spanish Am.					.212							
Dep. Ratio												
White Fert. Ratio												
Span. Fert. Ratio												
P. Now Married												
P. Diff. House 1965					-.206 ¹							
P. Diff. County 1965					-.189							
P. Diff. State 1965							-.183 ¹					
P. Abroad 1965												
P. White Collar												
P. Blue Collar												
P. Farm Worker												
Density A*	.795 ⁴	.395 ⁴	.187 ¹						.350 ⁴			
Density B** (Anglo)			.629 ⁴									
Density B (Span. Am.)			.286 ²									
P. Utility Gas				.412 ⁴								
P. Bottled Gas				.266 ²								
P. Electricity												
P. Rentals 0-99									-.211			
P. Rentals 100-149									.290 ²			
P. Rentals 150+												
P. Income 0-3.9†					-.712 ⁴		-.413 ⁴	-.658 ⁴				
P. Income 4-9.9†				.223 ¹	-.263 ²							
P. Income 10-24.9†						.506 ⁴	.216 ²					
P. Below Poverty						-.449 ³						
P. House Value 0-9.9†									.477 ⁴			
P. House Value 25+									-.234 ¹			
P. Span. Tenure								-.364				
P. House Built 1965-70												
P. House Built 1960-65	.167							-.422 ²				
P. House Built -1965												
P. Elem. Educ.												
P. H.S. Educ.						.294 ¹						
F. Age Eligibility††												
Multiple Correlation Coefficient	.775 ⁴	.760 ⁴	.834 ⁴	.732 ⁴	.734 ⁴	.738 ⁴	.753 ⁴	.501 ²	.617 ⁴	.464 ⁴	.490 ⁴	.441 ⁴
P. of Variance Explained (R ²)	.601	.577	.695	.530	.539	.545	.567	.251	.381	.215	.240	.195

* 3 or less persons per unit
 ** 1 or less person per room
 † in thousands
 †† only included for female unemployment

Levels of significance: ¹ = 0.025
² = 0.01
³ = 0.001
⁴ = 0.0005

Table 34. Beta Coefficients, Multiple Correlation Coefficients and Percent of Variance Explained by Selected Enumeration District Characteristics for Dependent Variables, Non-Geothermal Sample

Variables	Age Eligibility				Labor Force Participation				Unemployment			
	M	F	W	SA	M	F	W	SA	M	F	W	SA
P. Spanish Am.												
Dep. Ratio												
White Fert. Ratio												
Span. Fert. Ratio				-.570 ¹								
P. Now Married												
P. Diff. House 1965												
P. Diff. County 1965				-.483 ¹								
P. Diff. State 1965					-.488 ¹		-.411 ¹	-.408 ²				
P. Abroad 1965									.326			
P. White Collar												
P. Blue Collar												
P. Farm Worker												
Density A*	.688 ¹	.603 ¹	.491 ¹					-.278 ²				
Density B** (Anglo)		.370 ²	.472 ¹	.507 ¹								
Density B (Span. Am.)												
P. Utility Gas												
P. Bottled Gas				.474 ¹								
P. Electricity												
P. Rentals 0-99								-.478 ²	-.366 ²		.284 ¹	
P. Rentals 100-149												
P. Rentals 150+												
P. Income 0-3.9†					-.667 ¹							
P. Income 4-9.9†												
P. Income 10-24.9†				-.258 ²		.784 ¹	.647 ¹		-.461 ²			
P. Below Poverty												
P. House Value 0-9.9†												
P. House Value 25+									-.634 ¹		-.740 ¹	
P. Span. Tenure												.467 ²
P. House Built 1965-70												
P. House Built 1960-65								-.723 ¹				
P. House Built -1965								-.455 ¹				
P. Elem. Educ.				.220 ¹					.573 ¹		-.440 ²	
P. H.S. Educ.												
Multiple Correlation Coefficient	.858 ¹	.835 ¹	.931 ¹	.835 ¹	.833 ¹	.784 ¹	.871 ¹	.743 ¹	.826 ¹	.548 ²	.821 ¹	.637 ²
P. of Variance Explained (R ²)	.736	.697	.867	.698	.695	.615	.758	.552	.683	.301	.674	.406

* 3 or less persons per unit
 ** 1 or less person per room
 † in thousands

Levels of significance: ¹ = 0.025
² = 0.01
³ = 0.001
⁴ = 0.0005

had an average annual net outmigration rate of .7 percent for 1930-70 (see Section 3A.). Thus this income effect may be due to a lesser net outmigration of males from high income ED's, relative to lower income ED's--perhaps there are lesser disadvantages to remaining in the county for higher income young males.

Nongeothermal sample results for age eligibility differ from those for the entire sample only for SA's. For SA's, an additional independent variable is important. County mobility has a negative effect, due perhaps to added fertility from assumed young (18-mid 30) county immigrant parents combined with infants accompanying the parents who subsequently may be counted by the Census as ages 0-4. Labor force participation for the whole sample has a significant inverse relationship with low income and poverty, and for females and whites, a positive relationship with high income. These results correspond closely to those of Baer (1972) which showed for all male age groups, except 14-19 and 65+, significant positive effect on labor force participation for median earnings of the labor force. The interpretation is direct and obvious.

Since 1970, this effect may have diminished, due to the tendency for low income workers who have lost their jobs to remain in the labor force (i.e., because they are looking for work, they are categorized as in the work force), in order to obtain unemployment benefits. For the geothermal sample the above income effects and interpretations hold with three additional specific effects. For females there is a positive relationship with percent electrical house heating. This is probably the result of urban gradients of significantly greater electrical usage in the higher income areas of the three major towns. These gradients are reflected in correlations of electrical heating with income 0-3,999, income 4,000-9,999 and income 10,000-24,999 of -.494, -.348, and .519. A related effect is a positive effect for males and whites from recent (1965-70) house construction. This would also appear to reflect an income effect, as the above respective income correlations for housing construction 1965-70 are -.279, -.373, and .418.

Another result for the geothermal areas is a positive relationship, except for males, with high school education. This result also corresponds to consistent positive correlations of age-specific labor force participation with age-specific education (median school years completed) in the Baer (1972) study. Although there are no such present results for males, the arguments of Baer, emphasizing the importance of education to employers in job hiring, would seem applicable.

For the nongeothermal sample, the above effects for income (and highly correlated low rental variable) are interpreted as before. The significant inverse effect from interstate migration for males and whites is perhaps due to aged interstate immigrants--mostly retirees--selectively locating in more rural areas of the county or returning to the areas. This immigration of older residents is substantial--estimates of net migration 1960-70 for males and females aged 65+ are 9.7 percent and 9.2 percent.

Results for employment for the whole sample support, in general, a hypothesis that poverty and low income increase unemployment. For males the most significant effect is a positive one with poverty. The significant positive

effect from greater housing unit densities of 3 persons or less may be due to positive effects on employment from the higher housing unit densities associated with families--family responsibilities would lead to greater employment. Since regression analysis for female unemployment against the independent variables was nonsignificant for the entire sample, it was decided, in this single instance, to include the nonunemployment dependent variables as independent variables. The resultant inverse effect of female age eligibility may well be due to a positive effect with fertility ($r[\text{female age eligibility, white fertility}] = -.407$, $r[\text{female age eligibility, SA fertility}] = -.132$). Sweet (1972) demonstrated the positive effect on unemployment from young children for rural farm wives, corroborating his own results for urban wives. The positive unemployment effect of rentals 0-99 corresponds to the basic unemployment hypothesis of this paper, but is contrary to Sweet's results for rural farm wives, as well as to results cited by Sweet on urban wives. The inverse dependency ratio effect would appear contrary to the age eligibility effect, and may be due to a regression error. For whites the positive effect of poverty corresponds to the explanation given above for males. The positive effect of bottled gas is likely due to the greater presence of bottled gas for house heating in poorer areas ($r \text{ bottled gas, income } 0-3,999 = .313$).

SA unemployment is most strongly positively related to the white fertility ratio. This is likely the result of high SA fertility ($r[\text{SA fertility, white fertility}] = .357$), with an explanation corresponding to that of Sweet referred to before in the discussion of female unemployment. The negative effect from electrical heating likely follows the same reasoning for electrical heating given above for female geothermal work participation. Unemployment shows greater differences between geothermal and nongeothermal than did the previous sets of dependent variables. For geothermal areas all categories have positive relationships with fertility--as explained above. However, the reason for the greater importance of fertility in geothermal, as opposed to nongeothermal, areas is unexplained. The positive relationships with poverty for males and with gas heating usage for whites are direct economic effects--gas usage follows a pattern opposite to that for electricity.

For the nongeothermal region, economic-related variables are dominant and self-evident for the non-SA categories. For nongeothermal SA's, contrary to all previous results, fertility (SA) exerts a negative unemployment effect. Perhaps for an unknown reason, in these more rural ED's, there is more pressure and opportunity for employment in larger size SA families. The positive marital status effect is unexplained, while the high housing value result is ascribed to direct economic reasons.

Implications of Geothermal Development on Regional Employment

Imperial County has had a stable agriculturally-dominated economy for decades. For these years the county work force has had lower age and educational levels than the state. Subject to a .7 percent annual outmigration, the county has lost many of its skilled and trained youth--lowering the average skill levels of those remaining. Finally there is a large,

highly seasonal, and currently about half non-U.S.-resident farm labor work force. The prospective advent of geothermal energy development may alter each of the above fundamental county economic factors. The dominance of agriculture may be reduced or displaced by a large-scale energy-industrialization process. It is also necessary to consider concurrent trends, such as rising salinity of the Colorado River, the sole source of county agricultural water, which may reduce crop yields and cause further shifts to salt-tolerant (and often less profitable) crops.

The second fundamental feature, the presence of a large and partly nonresident farm labor segment--a feature related to the one above--might be somewhat altered by energy development. As detailed in Section 7A, a total of 150 farm laborers are estimated to be displaced from the land effect alone in 2010, assuming constant 1970 agricultural productivities. Hence a substantial low-skilled farm labor segment will likely remain present in 45 years, even with geothermal development, unless either decline in county agriculture or large-scale industrialization takes place.

The third major historical influence of persistent net outmigration, especially of young adults, may be altered by the attraction of jobs directly and indirectly created by geothermal energy. However, concurrent trends such as the recent national trend of net return to rural areas, may alter county migration streams as much or more than geothermal. One factor mitigating against a large immigration is the county's lack of climate, coastal, and cultural attractions characteristic of the major labor areas of California. The latter attractions might, of course, appear as part of the energy development process. Judging from results of the Gray (1969) study discussed earlier in this section, a large proportion of potential local geothermal workers might not possess the appropriate skills for newly created jobs, and thus may continue to outmigrate. This problem would appear potentially more severe for young SA's, who possess below average education and training. Even in the current pregeothermal labor market, the high level of unemployment suggests a population pool of employed available, especially SA's, who need to be trained for more skilled jobs. It would appear important for geothermal planners and policy makers to consider establishment of retraining centers, in order to avoid either continuing departure of lesser-skilled young adults or the necessity for workers to travel outside the labor region to obtain retraining, as was done in Gray's study region.

Having detailed several fundamental county economic forces and their likelihood for change, we may ask, how might the results of the regression analysis help elucidate such future processes? One inability of regression is indication of cause and effect. This is complicated further by economic processes, which are often circular. Nevertheless, one may speculate on several important age eligibility and participation implications of the regression for energy development. The first of these are potential enhancement of age eligibility if future county fertility levels are reduced, potential increases in labor force participation if average county personal income levels rise from geothermal development, potential decreases in participation if immigration of aged persons for retirement increases (possibly due to concurrent trends). Regression implications for unemployment are more complex, and must be examined by category. For the male and

white categories, a direct reduction in unemployment from more ample personal income and decreased poverty, stemming from geothermal development, may be inferred. For females, unemployment may be reduced through higher age eligibility, if county fertility levels are reduced by geothermal events. Finally, SA unemployment may be reduced if fertility lessens, due to the positive SA fertility correlation previously referred to.

In general geothermal influence on the county fertility pattern (see Table 30) by an increasing urban proportion or by high proportions of white immigrants may result in an older age structure. This, combined with the lower fertility and geothermal increases in personal income, may effect increases from the present low levels of county employment, relative to total population, age eligible population, and the work force.

A feature of the subsamples discussed earlier is geographic specificity for localized effects, such as certain pollutants and nonelectrical uses. If nonelectrical employment increases are even moderately localized in geothermal ED's, the regression differences between subsamples may be of use to planners. One such difference for females and SA's is the lesser influence in geothermal areas of economic variables, and greater influence of fertility. Therefore planners might consider that geothermally-caused increases in constant dollar per-capita income may be of less importance than fertility reductions in reducing unemployment, in areas of nonelectrical use.

8. Population Projections

Fifty-year population projections (Table 35) were done for Imperial County under a varying series of assumptions. Since any population projection is based entirely on assumed birth, death, and migration rates and age distributions, these types of forecasts must be used with a great deal of caution. An analyst can only say "If . . . , then. . . ."

The county was in a fixed state for projections for the period of 1930-70. However, it is a mistake to assume any fixity of rates for the future. In addition to the potential development of geothermal energy, other trends which might disrupt this steady state are the large recent national pattern of movement to the South, Southwestern, and Rocky Mountain regions, and possible changes in border legalities.

For each of these four projections two base years were used, 1970 and 1975. The 1970 base year is used, because it is the date of the last U.S. census of population, a time at which the entire county population was counted. This base year allows comparability with similar 1970 data on other counties. 1970 vital statistics (e.g., age-specific birth and death rates) were obtained from the document, Vital Statistics of California 1970 (State of California Department of Public Health, 1971).

The 1975 base year was used because of the special census which was taken for the county of Imperial by the State Department of Finance in 1975. The author of this projection makes no estimation as to the validity of the special census, except to mention that the total population from the special census is the one used officially by the State of California for 1975 (Statistical Abstract of California, 1975). Once the 1975 total population of 83,100 on January 1 is assumed (an average of the figure of 82,100 for July 1, 1974, and 84,100 for July 1, 1975, appearing in the Statistical Abstract, 1975), the age-specific population for 1975 can be assumed by projecting the 1970 U.S. Census age-specific population to 1975 under the assumptions of projection I (below). This 1975 population projection totaled 80,806. It was then scaled up by multiplying all age groups by the fraction $83,100/80,806$. This fractional scaling, which is only a factor of about 1.025, was thought the best way to resolve differences in the 1970 U.S. Census and the special census, as there are no accurate migration figures (either total or age-specific) for the period 1970-75.

Since the 1975 base year population is for January 1, vital rates were estimated by averaging vital rates for 1974 (State of California Department of Public Health, 1976), and vital rates for 1975 (State of California Department of Public Health, 1976a). Since the county crude birth rate dropped by 16.2 percent (Table 3) between 1970 and 1974 and rose by about 5 percent in 1975, the 1975 base year projections eventually result in smaller total numbers than the 1970 base year projections (Table 35).

TABLE 35. SUMMARY OF POPULATION PROJECTIONS
FOR IMPERIAL COUNTY

	<u>1970</u>	<u>1980</u>	<u>1990</u>	<u>2000</u>	<u>2010</u>	<u>2020</u>
<u>1970 Base Year</u>						
Series						
I	74,492	88,568	106,194	124,603	148,124	175,081
II	74,492	75,466	77,448	76,783	74,270	71,195
III	74,492	77,791	93,779	122,347	167,633	231,851
IV	74,492	78,359	97,789	134,740	197,387	292,570
<u>1975 Base Year</u>						
Series						
I	83,100	88,816	101,563	113,436	125,361	136,945
II	83,100	82,754	82,753	80,709	75,901	69,267
III	83,100	84,780	96,975	120,980	152,293	192,584
IV	83,100	85,330	100,780	132,410	176,813	238,567

Since the projections for the two base years run to 2020, the 1970-based projections are 50-year, while the 1975-based projections are for 45 years. In the following explanation of the four projection series, a projection period of 50 years is used for discussion, with 45 year results in parentheses. Also projection figures cited are for 1970, with 1975 base year figures in parentheses.

The first two 50-year projections were performed in a standard manner as follows:

A first series of population forecasts (I) was done utilizing a standard population projection program (Keyfitz and Flieger, 1971). This series of projections assumes no migration--thus it increases the historical rate of -.01 to a projection rate of 0.0. Birth and death rates are assumed fixed, as they are in all subsequent projections. The justification of using such fixed rates is that death rates are unlikely to change substantially in the next 50 years, and fertility rates will vary in 40-year cycles, if the pattern of the first seven decades of this century continues (Easterlin, 1961). In the projection of population an averaging process would take place for cyclical fertility, so that assumption of fixed fertility is not too inaccurate. For projection (I) population in the year 2020, after 50 years of forecasting, will be 175,081 (136,945), and population rises at a rather steady rate for the 50 (45) year period.

The second series of projections (II) was done by assuming the 1930-70 trends for the county continued into the future. The migration rates and age distribution is averaged from those of both sexes in the county for the 20 years from 1950 to 1970. The unusual situation of male workers who moved to Mexicali in the 1960's, after the end of the Bracero Program, is adjusted for in the estimation of migration rates. As can be seen for (II), this regime of rates yields an eventual population in 2020 of 71,195 (69,267) persons--close to the starting value.

The potential stimulus of the county's present youthful age structure is clearly demonstrated by year 2020 projections of 175,081 persons for (I) versus 71,195 for (II). On a crude rate basis, the 1 percent difference in 1970 crude migration rates between (I) and (II) would account on a constant 1970 age structure for only about a 60 percent difference in 2020 totals. The actual 146 percent difference in these totals is attributable to a combination of the youthful age structure, high fertility, and the fertility dampening due to the high rates of outmigration prior to age 25 assumed in (II).

Possibilities for geothermal developments were incorporated into projections (III) and (IV). The key assumption for these is a linear increase in crude net migration rates calculated on the 1970 stationary age distribution (henceforth abbreviated as CNSMR = crude net stationary migration rates) until the time point of final installed capacity is achieved, with that time point's rate assumed thereafter. Geothermal development time scales were estimated from the only significant U.S. historical case--Sonoma County, California--and from known tentative corporate plans for geothermal development in Imperial County. Since Sonoma County's initial 11 MW of geothermal capacity, capacity has been added since 1971 at the approximate rate of 100 MW/year. Assuming

in Sonoma-Lake a total field capacity of 1500 mW and a constant future trend, one arrives at an estimated time scale of 25 years for complete development. Davis (1976) details present corporate plans for installation of power plant capacity running from 1978 to 1995. The spans of these two development scenarios were averaged to obtain a capacity installation span of 21 years for projection purposes.

Thus in projections (III) and (IV), CNSMR was increased linearly from 1970 (1975) to 1995 so that migration change is a function of power plant capacity. Year 1995 CNSMR was assumed at 20 percent for (III) and 30 percent for (IV) of the average crude migration rates 1950-70 for the five fastest growing California counties (these respective rates are 1 percent and 1.42 percent annually). The age distribution of immigrants was a weighted average of (1) the county pattern 1950-70 used for (I)--weighted .3; and (2) the U.S. age structure for intercounty mobility (Bogue, 1959)--weighted .7. Results of these geothermal projections again reveal the county's high potential for rapid increase.

For projection (III), the time scale is assumed to correspond to the establishment of a moderate-sized plant capacity and multipurpose use capability in the valley, which would be in place fully by 1995. This projection results in an eventual population for the county of 231,851 (192,584) in 2020, with increase more rapid in the second 25-year period.

For projection (IV), the assumed effects of geothermal development will be larger. The county will be assumed to develop enough of an economic base to attract substantial numbers of persons into the county. Although still at a rate short of such counties as Ventura, Riverside, San Bernardino, and Santa Barbara in the 1950's and 1960's. Here the eventual county population for 2020 is 292,570 (238,567), with fast growth in 1995-2020.

Note: For projections (III) and (IV), the probability age distribution of immigrants (beginning with age group 0-4, and ending with age group 85+ is the following: .0471, .0331, .0632, .0261, .0414, .1164, .1160, .0789, .0375, .0322, .0309, .0213, .0218, .0541, .0698, .0698, .0698.

For the 10-year projection series given in Table 35, the wide variation in (I)-(IV) is the result of change from the county's highly outmigratory pattern of 1930-70. The effect of the shift from outmigration to zero migration or immigration is amplified by the county's high fertility rates. This amplification is greater for the higher fertility rates assumed with the 1970 base year.

Projections (III) and (IV) are based on changes in migration rates corresponding to a scale-up in geothermal power plant capacity from 1970-95. This is not intended to be a direct time relationship $m(t) = f(C(t))$ where $m(t)$ is an age-specific migration rate at time t and $C(t)$ is county plant capacity, but rather to be a relationship $m(t) = f(C(t-k))$, where k is a lag in migration effect. The lagged function would seem more realistic for geothermal energy capacity in Imperial County, because the time sequence of energy uses is most likely to be electrical power generation first, and then nonelectrical uses of the energy. Since nonelectrical employment within the

county may eventually account for a substantial percentage of county geothermal employment, a lagged migration function would seem appropriate.

Lofting (1976) discusses the implications for input-output economics and employment of projections (II) and (III). In studying the population projections, it is important to point out that there may be concurrent trends which affect the population as much or more than geothermal energy. Some of these trends for 1970-2020 may well be unknown at present. However, one example of a recent concurrent trend that might affect the county is a national pattern since the 1970 Census of return of persons to rural areas, countering the trend of suburbanization in the 1950's and 1960's. Also, Imperial County, although having very high fertility, nevertheless is affected by the historically cyclical national fertility cycles. An unknown to U.S. population analysts is whether the sharp national fertility drop of the 1970's will continue, violating the historical cycles, or reverse and rise to a cyclical high. All such unknowns, besides the geothermal ones, are built into choice of a particular projection series. This researcher cannot predict the above national social forces on migration and fertility--instead the present analysis is intended to present certain assumptions and examine their consequences.

Another result of the projection series besides total population is the age and sex distributions resulting from the assumptions. In Table 36 age distributions of all year 2020 projections are presented and compared to initial values. The sizes of 2020 projected values for the youngest two age groups are higher in all series for 1970 base year (as compared to 1975 base year)--the cumulative age structural effect of the higher fertility in 1970, as compared to 1975. As these younger age groups are most variable of projected age groups among the four series, planners and policy makers might consider possible effects on hospitals, schools, etc. from assumption of a particular series.

For all the 2020 projections, the sex ratio for the oldest age group (65+) is less than 1.0, as compared to a 65+ sex ratio of 1.18 in 1970. For the retirement age population of the county such a sex-ratio reversal is significant. It is also useful information to planners and private businesses concerned with older persons.

TABLE 36. AGE DISTRIBUTIONS OF POPULATIONS PROJECTED TO YEAR 2020

<u>Age</u>	<u>Imperial County (1970)</u>		<u>United States (1970)</u>	
	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>
0-4	9.8	9.6	8.6	8.6
5-9	12.4	11.8	9.6	9.8
10-19	23.3	22.7	19.4	19.2
20-39	21.3	24.6	29.7	28.0
40-64	25.0	24.2	27.4	26.4
65+	<u>8.0</u>	<u>6.8</u>	<u>5.3</u>	<u>8.0</u>
	36,871	37,621	98,912 *	104,300 *

*In thousands

(To be continued)

TABLE 36 (Continued)

<u>Age</u>	<u>(I)</u>		<u>(II)</u>		<u>(III)</u>		<u>(IV)</u>	
	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>	<u>Male</u>	<u>Female</u>
Imperial County (2020)--1970 Base Year								
0-4	12.0	11.0	7.3	6.5	14.5	13.3	15.6	14.3
5-9	11.1	10.3	7.3	6.5	12.7	11.6	13.4	12.3
10-19	19.7	18.3	14.4	12.8	21.0	19.3	21.6	19.9
20-39	29.6	28.1	27.3	24.9	28.9	27.8	28.4	27.6
40-64	24.4	22.8	31.5	30.6	18.2	20.0	16.8	18.7
65+	<u>2.9</u>	<u>9.2</u>	<u>11.9</u>	<u>18.4</u>	<u>4.4</u>	<u>7.6</u>	<u>3.8</u>	<u>6.9</u>
	85,186	89,895	32,791	38,403	114,690	117,161	146,111	146,459
Imperial County (2020)--1975 Base Year								
0-4	9.0	7.9	5.1	4.5	11.2	10.0	12.2	10.9
5-9	8.7	7.7	5.2	4.5	10.1	9.0	10.7	9.5
10-19	16.4	14.7	11.5	10.0	17.8	15.8	18.4	16.4
20-39	29.6	26.7	24.7	22.0	29.5	27.6	29.5	27.8
40-64	28.2	27.2	38.4	35.3	24.8	25.7	23.1	24.4
65+	<u>7.9</u>	<u>15.5</u>	<u>14.7</u>	<u>23.4</u>	<u>6.4</u>	<u>11.6</u>	<u>5.7</u>	<u>10.7</u>
	65,331	71,614	31,334	37,933	93,435	99,149	116,843	121,724

9. Transferability of Methods and Results

The study area for this project is only one county, containing less than 85,000 persons, and a geothermal resource of perhaps 15,000 mW maximal size. Since there are many other potentially exploitable U.S. geothermal fields--mostly in the West--one important objective of this study is to develop techniques or identify prior ones which might be applied in other localities. This section will examine each of the major methods used in the report for their transferability to other regions.

The data was mostly obtained from the 1970 U.S. Census (1973 and 1974). Since Imperial County has not changed significantly in its population characteristics since the 1930's, 1970 data is considered relevant in 1977. However, in geothermal areas of rapid population growth, the population change might well invalidate use of 1970 data seven years later. In such a case, the data for a study like the present one would be unavailable--at least until the 1980 Census results are released in the period 1981-84. These faster-growth areas would have to rely on special federal, state, or local interim censuses or surveys, which would likely have county or city areas as the smallest units and which would probably be much less accurate than the decennial federal census. The studies done in report sections 2, 3, 6, and 7A and 8 might be amenable to interdecennial data, but the other analyses would not be possible. It should be mentioned that even in historically static counties, such as Imperial, it may well be advantageous to use more recent data than the last federal census. However, the plus of greater recency of such data should be weighed carefully against the minus of likely greater inaccuracies in sampling and data collection.

In the 1970 census, urban areas--those contained within the census-defined regions, urbanized areas and standard metropolitan statistical areas (SMSA)--have a much larger and more detailed body of published data on population characteristics. For a geothermal study in an urbanized area or SMSA, greater number and detail of characteristics could be investigated. The fifth count ED data coverage would remain the same. Another problem in urban areas would be choice of population affected by geothermal development. If, for the sake of argument, a large geothermal field were located 50 miles from the Denver city limits, the choice of population susceptible to, say, nonelectrical or noise effects would be considerably more difficult to delineate than in Imperial County.

Another data problem, which has been important to the present study, is that of seasonality in certain socioeconomic characteristics and seasonality in dates for census collection. An example from Imperial County is measurement of the number of farm laborers. It makes a significant difference whether such data is collected in the maximal harvest times of May and January, or in off-harvest times such as February to mid-April. Another Imperial County

example of such seasonality is measurement of vacancy rates in a county with both winter tourists and considerable summer travel of residents due to the extremely hot weather. Although the present county is far more seasonal than most, researchers anticipating similar studies in other areas should carefully check variables for such seasonal tendencies in order to improve and strengthen their analysis.

In the present study, the key socioeconomic variables turned out to be ethnic grouping, age structure, fertility, migration, household density, and a few others. However, prior to commencement of the research, there was little indication which variables would be most important. Likely, other geothermal areas will have a partially or completely different list of key variables; thus it may be necessary to begin with a sizeable list of variables in order gradually to identify the key ones.

Assuming that currently applicable ED data is available, the statistical methods of regional computer graphics, discriminant analysis, correlation, and regression analysis are transferable to studies of other areas. In preparing computer maps of rural areas, ED boundary maps, which are drawn by local governments, may contain certain errors or inadequacies. For mapping there are several line-printer software routines available, such as Automap II and Symap. Another possibility is to digitize the map boundaries, and use a plotter and associated mapping software for a finer plot. Choice would depend on the researcher's computer costing and core size, as well as his desire for fineness of detail. For computer plotting of population by age group, routines such as PYRAMID (Pick, 1974) and PLATO (Handler, 1972) are available.

For the regression analysis, the common statistical problem of choice of independent and dependent variables presents itself--choices dependent on understanding of the key socioeconomic processes potentially affecting geothermal development. Two other well-documented problems in design of regressions and discriminant analyses are errors due to high intercorrelations of independent variables (non-orthogonality) and choice of stepwise versus nonstepwise techniques. Detailed information on these sources of error are contained in the book by Lachenbruch (1975) and in statistical textbooks.

The estimation of farm labor displacement due to geothermal land use would appear applicable elsewhere only in agricultural areas. Few industries other than agriculture have work forces with a direct relationship to land area. Even in agricultural areas the analysis is complicated for projection purposes by future crop and farm worker productivity changes. Also, geothermal development may cause indirect land losses, such as those caused by geothermal-related industrialization. Another problem is the large number of geothermal unknowns, such as well spacing and subsidence. It is due to these unknowns that ranges of interstitial land losses were given in Section 7A, rather than single value.

The population projection methodology is based on standard techniques (Keyfitz, et al., 1971), and would appear transferable to other areas of county size or larger. In Imperial County, as elsewhere, the major projection unknowns are fertility and migration values. Since fertility is so complicated and difficult to predict, demographers often end up assuming the latest

fertility values for the entire length of the projection. Cyclical U.S. fertility shifts in the first half of the 20th century have been studied by Easterlin (1961), and cyclical projection assumptions for fertility might be a wiser choice for another county, although fixed fertility was assumed for Imperial.

Projection assumptions on future migration generally require thorough understanding of historical volume and age structure of migrants. Three types of migration must be distinguished: immigration (persons entering a region over a time period), outmigration (persons leaving a region over a time period), and net migration (immigration minus outmigration over a time period). One difficulty in standard projections is that net migration values are used, although immigration and outmigration are much more explainable as individual socioeconomic processes. Values for net migration, which is a difference between in- and out-, may be less meaningful. In a scenario for a geothermal region in which the economy is being fundamentally altered, it is very difficult to estimate the future age distribution for net migration, as even the initial values may not make sense. The answer would appear to lie in closely studying in- and outmigration for the region, with the restriction that much more census data is available for immigration than outmigration.

The transferability of Imperial County results directly to other regions would appear highly dangerous, as there are so many unique features to the county, such as proximity to Mexico, young age structure, high SA population, and others. Therefore, if possible, it would appear better to repeat even a small subset of the above analyses, rather than transfer specific results directly.

References

- Armstead, Christopher. 1973. Geothermal Economics, in Geothermal Energy. Geneva: UNESCO.
- Baer, Roger K. 1972. Male Labor Force Participation Revisited. *Demography* 9(4):635-654.
- Baker, Joseph N. 1974. A City Invests in Its Future, in Proceedings, Conference on Research for the Development of Geothermal Energy Resources. National Science Foundation, 335-339.
- Barnea, Joseph. 1972. Geothermal Power. *Scientific American* 226(1):70-77.
- Biggar, J. C., and E. W. Butler. 1969. Fertility and Its Interrelationships with Population Size in a Southern State. *Rural Society* 34:528-536.
- Birsic, Rudolph. 1974. The Geothermal Steam Story. Fullerton: R. J. Birsic.
- Bogue, D. J. 1959. The Population of the United States. Glencoe, Illinois: The Free Press.
- Bougehey, Arthur S., D. Wilkin, and J. B. Pick. 1972. Hydrology and Water Use in Kern County: A Modelling Study of Human Carrying Capacity. Unpublished paper presented at the Eighth American Water Resources Conference, St. Louis.
- Bradshaw, Benjamin S. 1976. Potential Labor Force Supply, Replacement, and Migration of Mexican American and Other Males in the Texas-Mexico Border Region. *International Migration Review* 10(1):29-46.
- _____, and Frank Bean. 1973. Trends in the Fertility of Mexican-Americans: 1950-1970. *Social Science Quarterly* (March, 1973):688-696.
- Butler, Edgar W., F. Stuart Chapin, George C. Hemmens, Edward J. Kaiser, Michael A. Stegman, and Shirley F. Weiss. 1969. Moving Behavior and Residential Choice: A National Survey. National Cooperative Highway Research Program Report 81, Highway Research Board. Washington, D.C.: National Academy of Sciences.
- Cataldi, R., P. DiMario, and T. Leardini. 1973. Application of Geothermal Energy to the Supply of Electricity in Rural Areas. *Geothermics* 2(1): 3-16.

- Collver, O. A. 1968. Women's Work Participation and Fertility in Metropolitan Areas: An International Comparison. *Demography* 5:55-60.
- _____, and E. Langlois. 1962. The Female Labor Force in Metropolitan Areas: An International Comparison. *Economic Development Cultural Change* 10(4):367-385.
- Dagodog, W. Tim. 1975. Source, Regions and Composition of Illegal Mexican Immigration to California. *International Migration Review* 9(4):499-512.
- Davis, Cal. 1976. Preliminary Scenario, Imperial Valley Region, State of California. Unpublished report, Jet Propulsion Lab, Pasadena, April 19, 1976.
- DeSandre, P. 1971. Recherche pur Micro-Zones sur les Relations entre Fecondite et Certaines Caracteristiques du Milieu Economique et Social Chans une Region Italienne. *Genus* 27:1-27.
- Dixon, W. J. (ed.). 1973. Biomedical Computer Programs. Berkeley: University of California.
- _____. (ed.). 1976. Biomedical Computer Programs (BMDP). Berkeley: University of California Press.
- Doctor, R. D., K. P. Anderson, et al. 1972. California's Electricity Quandary. III. Slowing the Growth Rate. Santa Monica: Rand.
- Easterlin, R. A. 1961. The American Baby Boom in Historical Perspective. *American Economic Review* 51:869-911.
- Eisenbeis, Robert A. and Robert B. Avery. 1972. Discriminant Analysis and Classification Procedures. Lexington, Massachusetts: D. C. Heath and Co.
- Environmental Systems Research Institute. Automap II Users Manual. Redlands, California: Environmental Systems Research Institute.
- Federal Energy Administration. 1974. Geothermal Energy. Final Task Force Report, Project Independence Blueprint. Washington: Federal Energy Administration.
- Force, Peter R. 1970. Adaptation of Input-Output Technique to a Small Economic Area. Master's thesis. Los Angeles: California State College.
- Fowler, John M. 1975. Energy and the Environment. New York: McGraw-Hill.
- Fulton, Maurice. 1974. Industry's Viewpoint of Rural Areas, in Whiting, Larry R. (ed.), *Rural Industrialization*. Ames: Iowa University Press.
- Galle, Omer R., John D. McCarthy, and William Zimmerin. 1973. Population Density, Sound Structure, and Interpersonal Violence: An Intermetropolitan Test of Competing Models. Paper presented at American Psychological Association Meetings, Montreal, Canada, August 29.

- Galle, Omer R., John D. McCarthy, and Walter R. Gove. 1974. Overcrowding and Isolation: Some Behavioral Consequences. Paper presented at annual meeting of Pop. Assoc. Am., New York City, April 18-20.
- Gellner, Christopher G. 1974. Regional Differences in Employment and Unemployment, 1957-72. *Monthly Labor Review* 97(3):15-24.
- Ginther, Jerry D., Howard E. Lindow, G. A. Hornberger, Robert W. Shively. 1974. Corporate and Community Decision Making for Locating Industry, in Whiting, Larry R. (ed.), *Rural Industrialization*. Ames: Iowa University Press.
- Goldsmith, Martin. 1971. Geothermal Resources in California: Potentials and Problems. EQL Report 5. Pasadena: Environmental Quality Laboratory.
- Gray, Irwin. 1969. Employment Effect of a New Industry, in a Rural Area. *Monthly Labor Review* 92(6):26-30.
- Grebler, Leo, Joan W. Moore, and Ralph G. Guzman. 1970. *The Mexican-American People*. New York: The Free Press.
- Greenwood, Michael J., and Patrick J. Gorneky. 1971. A Comparison of the Determinants of White and Nonwhite Interstate Migration. *Demography* 8(1):141-155.
- _____, and Douglas Sweetwood. 1972. The Determinants of Migration Between Standard Metropolitan Statistical Areas. *Demography* 9(4): 665-681.
- Handler, Philip, and Judith Sherwood. 1972. The Plato System Population Dynamics Course, in Greville, T. N. E. (ed.), *Population Dynamics*. New York: Academic Press.
- Haren, Claud. 1974. Location of Industrial Production and Distribution, in Whiting, Larry R. (ed.), *Rural Industrialization*. Ames: Iowa University Press.
- Hauser, Philip. 1971. The Census of 1970. *Scientific American* 225(1):17-25.
- Heer, D. M. and J. W. Boynton. 1970. A Multivariate Analysis of Differences in Fertility in United States Counties. *Social Biology* 17:180-194.
- _____, and E. S. Turner. 1965. Areal Differences in Latin American Fertility. *Population Studies* 18:279-292.
- Hernandez, Jose, Leo Estrada, and David Alvarez. 1973. Census Data and the Problem of Conceptually Defining the Mexican American Population. *Social Science Quarterly* (March, 1973):671-687.
- Hernandez, Juan P. 1974. El Comercio, La Zona Libre y Algo mas en el Municipio de Mexicali. *Boletin Economico* 1(1):5-25.

- Holt, Ben, and John Brugram. 1974. Investment and Operating Costs of Binary Cycle Geothermal Power Plants, in Proceedings, Conference on Research for the Development of Geothermal Energy Resources. National Science Foundation, 292-300.
- Hunter, L. C., G. L. Reid, and D. Boddy. 1970. Labor Problems and Technological Change. London: George Allen and Irwin Ltd.
- Imperial County. 1970. Overall Economic Development Plan. El Centro: Imperial County Economic Development Commission.
- _____. 1973. Ultimate Land Use Plan. El Centro: Imperial County.
- James, R. 1970. The Economics of the Small Geothermal Power Station. Geothermics Special Issue 2:1697-1704.
- Johnson, Claude, et al. 1976. Agricultural Resources. Preliminary Table, NSF Imperial County Geothermal Project.
- Keyfitz, Nathan, and Wilhelm Flieger. 1971. Population: Facts and Methods of Demography. San Francisco: Freeman.
- Kjos, Kaare Saxe. 1974. The Role of Industry in the Socio-Economic Development of Calexico. Master's thesis, United States International University.
- Lachenbruch, Peter. 1975. Discriminant Analysis. New York: Hafner Press.
- Lansing, John B., and Eva Mueller. 1967. The Geographic Mobility of Labor. Ann Arbor: Survey Research Center.
- Lapp, Ralph. 1973. The Logarithmic Century. Englewood Cliffs: Prentice Hall.
- Larson, Tod. 1976. Costs of Geothermal Development. Preliminary report, NSF-Imperial County Geothermal Project.
- Lessing, Lawrence. 1973. Power from the Earth's Own Heat, in Boughey, A. S. (ed.), Readings in Man, the Environment of Human Ecology. New York: MacMillan.
- Levine, Louis. 1957. Unemployment by Locality and Industry, in The Measurement and Behavior of Unemployment. Princeton: Princeton University Press.
- Lienan, Paul J., and John W. Lund (eds.) 1974. Multipurpose Use of Geothermal Energy. Klamath Falls: Oregon Institute of Technology.
- Lindal, B. 1970. The Production of Chemicals from Brine and Seawater Using Geothermal Energy. Geothermics, Special Issue 2.
- _____. 1973. Industrial and Other Applications of Geothermal Energy, in Armstead, H. C. H., Geothermal Energy. Paris: UNESCO Press.

- Linton, A. M. 1974. Innovative Geothermal Uses in Agriculture, in Lienan, Paul J., and John W. Lund (eds.), Multipurpose Use of Geothermal Energy. Klamath Falls: Oregon Institute of Technology.
- Lofting, Everard, and Adam Rose. 1976. Economic Analysis for NSF-Imperial County Geothermal Project. Preliminary report on input-output analysis.
- Melvin-Howe, G. 1968. The Geography of Death. New Scientist 40:612-614.
- Morrison, Peter A. 1971. Chronic Movers and the Future Redistribution of Population: A Longitudinal Analysis. Demography 8(2):171-184.
- _____. 1972. Population Movements and the Shape of Urban Growth. Santa Monica: RAND.
- Nakamura, S. 1970. Economic of Geothermal Electric Power Generation at Matsukawa. Geothermics, Special Issue 2.
- Nathan Associates. 1968. Industrial and Employment Potential of the United States-Mexico Border. Washington: U.S. Department of Commerce, Economic Development Administration.
- Penner, S. S., and L. Icerman. 1974. Energy, Vol. I. Reading, Massachusetts: Addison-Wesley Publishing Co.
- Perry, G. 1972. Unemployment Flows in the U.S. Labor Market. Brookings Papers on Economic Activity, No. 2:245-292.
- Peterson, Richard E., and Nabil El-Ramly. 1975. The Worldwide Electric and Nonelectric Geothermal Industry. Paper from Hawaii Natural Energy Institute.
- Pick, James B. 1974. Computer Display of Population Age Structure. Demography 11(4):673-682.
- _____. 1976. Correlates of Fertility and Mortality in Low Migration Standard Metropolitan Statistical Areas. Social Biology (in press).
- Pimentel, David, William Dritschelo, John Krummel, and John Kutzman. 1975. Energy and Land Constraints in Food Protein Production. Science 190: 754-761.
- Price, John A. 1973. Tijuana: Urbanization in a Border Culture. Notre Dame, Indianapolis: University of Notre Dame Press.
- Robson, Geoffrey R. 1974. Geothermal Electricity Production. Science 84:371-375.
- Ross, S. H. 1970. Geothermal Potential of Idaho. Geothermics, Special Issue 2.
- Saben, Samuel. 1964. Geographic Mobility and Employment Status, March 1962-March 1963. Monthly Labor Review (87).

Samora, Julian. 1971. Los Mjoados: The Wetback Story. Notre Dame, Indianapolis: University of Notre Dame Press.

Sheehan, Mike, et al. 1976. Report of the Estimated Impact of Locating a One Hundred Acre Geothermal Facility on Various Lands. Preliminary report, NSF-Imperial County Geothermal Project, August.

State of California. 1976. California Statistical Almanac, 1975. Sacramento: State of California.

_____, Department of Public Health. 1930-76. Vital Statistics of California. Various volumes. Sacramento, California.

_____, Department of Public Health. 1976a. Personal communication, December.

Steinhart, John S., and Carol E. Steinhart. 1974. Energy Use in the U.S. Food System. Science 184:307-316.

Stoddard, Ellwyn R. 1976. Illegal Mexican Labor in the Borderlands. Pacific Social Review 19(2):175-210.

Sweet, James A. 1972. The Employment of Rural Farm Wives. Rural Society 37(4):553-577.

Thompson, Warren S. 1955. Growth and Changes in California's Population. Los Angeles: Hayes Foundation.

Uhlenberg, Peter. 1973. Fertility Patterns Within the Mexican-American Population. Social Biology 20(1):30-39.

U.S. Bureau of the Census. 1951. Census of Population: 1950. Vol. 2. Characteristics of the Population. Washington, D.C.: Government Printing Office.

_____. 1961. Census of Population: 1960. General Social and Economic Characteristics. Final Report PC(1)-C. Washington, D.C.: Government Printing Office.

_____. 1971a. Census of Housing: 1970. Vol. 1. Housing Characteristics for States, Cities and Counties. Washington, D.C.: Government Printing Office.

_____. 1971b. Census of Population: 1970. General Social and Economic Characteristics. Final Report PC(1)-C. Washington, D.C.: Government Printing Office.

_____. 1973. U.S. Census of Population, 1970. General Population Characteristics. Final Report PC(1)-B. Various volumes. Washington, D.C.: Government Printing Office.

_____. 1974. U.S. Census of Population, 1970. Fifth Count for ZIP Codes, Counties, and Smaller Areas. Washington, D.C.: Government Printing Office.

U.S. Senate, 91st Congress. 1971. Migrant and Seasonal Farmworker Powerlessness. Hearings on Border Commuter Problem. Washington, D.C.: Government Printing Office.

Verdugo, Sergio N. 1974. El Nivel de Vida Regional en Mexico. Boletín Económico 1(1):26-48.

Vollintine, Larry, and Oheh Weres. 1976. Public Opinion Concerning Geothermal Development in Lake County, California. Berkeley: Lawrence Berkeley Laboratory (LBL-4447).

Von Arsdol, Maurice D., and Leo A. Schuerman. 1971. Redistribution and Assimilation of Ethnic Populations: The Los Angeles Case. Demography 8(4):459-480.

Wehlage, Edward F. 1974. Geothermal Energy's Potential for Heating and Cooling in Food Processing, in Lienan, Paul J., and John Lund (eds.), Multipurpose Use of Geothermal Energy. Klamath Falls: Oregon Institute of Technology.

_____. 1976. The Basics of Applied Geothermal Engineering. West Covina, California: Geothermal Information Services.

Werner, H. H. 1970. Contribution to the Mineral Extraction from Super-saturated Geothermal Brines, Salton Sea Area, California. Geothermics, Special Issue 2.

Whetten, Nathan L. 1971. Population Growth in Mexico. Paper prepared for the Select Commission on Western Hemisphere Immigration.

Whiting, Larry R. (ed.). 1974. Rural Industrialization. Ames: Iowa State University Press.

Wilson, R. D. 1974. Use of Geothermal Energy at Tasman Pulp and Paper Co. Ltd., New Zealand, in Lienan, Paul J., and John Lund (eds.), Multipurpose Use of Geothermal Energy. Klamath Falls: Oregon Institute of Technology.

Wong, C. M. 1970. Geothermal Energy and Desalinization: Partners in Progress. Geothermics, Special Issue 2.

Figures

AGE OBSERVED
80 POP. *****
75 STATIONARY
POP.
STABLE
POP. SSSSS

THIS LENGTH OF AXIS REPRESENTS 896 PEOPLE IN OBSERVED POP.

FIGURE 2. Age Structure
for Imperial County,
1950

FIGURE 3. Age Structure and Age-Specific Migration for Imperial County, 1960

FIGURE 4. Age Structure and Age-Specific Migration for Imperial County, 1970

FIGURE 6a. Dependency Ratio,
County of Imperial

Symbol Value Range

.....	.696- .735
.....	.735- .881
XXXXXXX	.881-1.007
0000000	1.007-1.573
0000000	1.573

FIGURE 6b. Dependency Ratio, City of Brawley

FIGURE 6c. Dependency Ratio,
City of El Centro

1 2 3 4 5 6 7 8 9 0

FIGURE 7a. Percent of Labor
Force Males, County of
Imperial

Symbol Value Range

.....

.397-.456

.....

.456-.491

XXXXXXXX

.491-.564

00000000

.564-.632

11111111

.632-.704

FIGURE 7b. Percent of Labor Force Males,
City of Brawley

FIGURE 7c. Percent of Labor Force
Males, City of El Centro

FIGURE 8. Percent of Total
Female Labor Force,
County of Imperial

Symbol	Value Range
.....	.444-.493
.....	.493-.537
XXXXXX	.537-.572
000000	.572-.603
000000	.603-.699

FIGURE 9. Mobility (Different House/Total Houses), Count of Persons 5 Years Old and Over by Residence in 1965

Symbol	Value Range
.....	.353-.431
.....	.431-.527
XXXXXX	.527-.610
000000	.610-.691
000000	.691-.995

FIGURE 10. County Mobility
(County Migration/Total Houses),
Count of Persons 5 Years Old and
Over by Residence in 1965

Symbol	Value Range
.....	.000-.029
.....	.029-.067
XXXXXXX	.067-.103
0000000	.103-.171
0000000	.171-.285

FIGURE 11. State Mobility
(State Migration/Total Houses),
Count of Persons 5 Years Old
and Over by Residence in 1965

Symbol	Value Range
.....	.000-.015
.....	.015-.036
XXXXXX	.036-.069
XXXXXXXX	.069-.137
XXXXXXXXXX	.137-.537